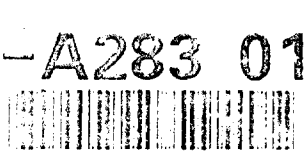


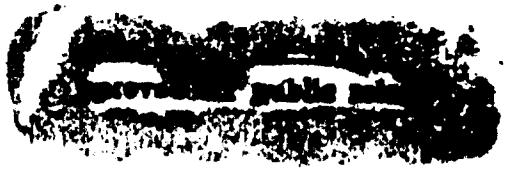
Logistics Management Institute

Toward a World-Class Engineering Organization

Making ISO 9000 the Foundation to Quality Management

CE308R1

Jeffrey Hawkins
James L. Hathaway



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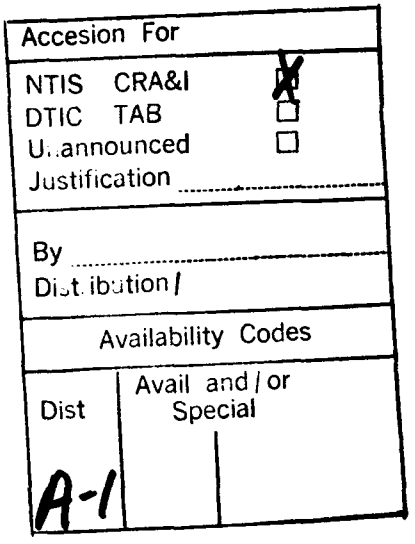

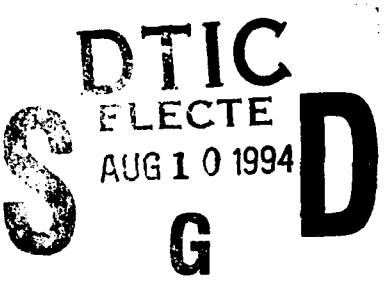

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Toward a World-Class Engineering Organization:
Making ISO 9000 the Foundation to Quality Management

Executive Summary

If it is to continue as the world's preeminent engineering and design organization, the U.S. Army Corps of Engineers (USACE) must fulfill its customers' demand for total quality products and excellent service. To Corps customers total quality means engineering and design products that meet their functional and technical requirements, are completed on schedule and within the given budget, and are delivered with exceptional customer service. In response to its customer's challenges, USACE has already launched several quality-related initiatives (e.g., *Total Army Quality*). However, those quality initiatives, as a whole, could be much more beneficial to the field activities implementing them if they were made part of a broader and integrated quality management system that would minimize lapses in quality by preventing most problems. When problems do arise, the system quickly identifies and corrects the faulty systems or procedures. Fortunately for USACE, a ready recipe for acceptable quality management systems — the ISO 9000 quality system standards — already exists.

The ISO 9000 standards, developed by the International Organization for Standards, are a series of generic quality system criteria that provide the fundamental framework for universally accepted quality management systems and establish the basic elements that comprise those systems. The European Economic Community is already using ISO 9000 to verify the legitimacy of quality systems across national boundaries. In the United States, ISO registration is growing rapidly because in certain industries, registration to ISO 9000 is contractually mandated or part of contractor selection criteria. For other quality-conscious firms, ISO standards offer a ready model for improving internal quality systems and therefore, efficiency, competitiveness, and productivity. Most registered companies are finding that the benefits of registering under ISO exceed the costs.

Currently, engineering processes at USACE field activities do not meet the minimum quality system standards set forth by ISO 9000. Those field activities can remedy their quality system shortfalls by adhering to the basic tenets of the ISO 9000 quality system standards, thereby increasing productivity, improving product quality, raising customer satisfaction, acquiring competitive advantages, motivating employees, and, perhaps most importantly, gaining recognition as a legitimate quality leader in the engineering industry. While this study focused primarily on USACE's engineering activities, the benefits of registration are maximized when all major elements of the project delivery process are

included within the scope of registration. The ultimate goal of field activities implementing ISO 9000 should be focused on the entire project delivery process.

We believe that USACE field activities will accrue benefits similar to those experienced by the private sector, but we recommend the Corps take a measured approach to adopting the ISO 9000 standards. The following recommendations offer USACE a strategy for adopting and becoming registered to the ISO 9000 standards.

- *Headquarters, USACE, should select two to four field activities to evaluate the costs and benefits of ISO 9000 registration.* Several USACE field activities have already expressed interest in ISO. HQUSACE should encourage their registration by sharing the development and documentation of ISO-qualified processes and ISO-awareness training. At the same time, HQUSACE should develop a test implementation strategy and establish the criteria that will define its success. The plan should include a strategy for expanding registration beyond engineering and beyond the minimum quality system requirements established by the ISO standards.

- *The USACE should encourage all its field activities to seek ISO 9000 registration if the test site results justify it.* The benefits of adopting the ISO quality standards are maximized when the leadership at the field activities is committed to quality improvement. HQUSACE should promote the program throughout its network of field activities and provide the needed ISO awareness and implementation guidance. Procedure and documentation templates from the test sites will help minimize costs for all subsequent registrations. Recognition and/or award incentives will further foster the needed internal commitment.

- *The USACE should take a leadership role in the engineering community and encourage its architectural and engineering contractors to pursue ISO registration.* A contractor selection process that encourages its suppliers to register under ISO 9000 will improve the quality, costs, and timeliness of the engineering products the Corps receives. While registration to ISO should not be required at this time, it can be used in lieu of or in conjunction with other USACE quality requirements during the acquisition process. The ISO quality system requirement can be advertised during contractor selection, will help to promulgate total quality ideals in the engineering community, and will simplify the process for evaluating the contractors' quality-control plans.

USACE's customers will continue to demand higher levels of quality and excellent service. Improving the total quality of its processes and assuring the total quality of the products it receives from its suppliers is a way for the USACE to foster a world-class engineering reputation and meet the increased needs of its customers.

Contents

CHAPTER 1

Introduction

BACKGROUND

With an annual engineering and design program of about $700 million, the U.S. Army Corps of Engineers (USACE) is the worlds largest engineering enterprise. Managing USACE's engineering activity is a demanding task, and major challenges must be faced if it is going to continue delivering the type of engineering and design products that its customers expect. In the past, customers came to the Corps because it had engineering expertise that few others possessed. Today, the business environment is changing – at the same time USACE's funding is shrinking, its customers are demanding the same quality products but with better services and a growing number of its customers are finding other ways to acquire some services that previously only USACE could deliver. USACE's customers want total quality – engineering and design products that meet their specific functional and operational requirements, are completed on schedule, satisfy environmental concerns, meet safety requirements, and are cost-effective to construct, operate, and maintain. Its customers also want the Corps to provide exceptional service and they want assurance in advance that the total quality they want is the quality they will get. USACE must find new and innovative ways to meet its customers changing expectations for high-quality products and excellent service.

Quality and customer service are not new concepts in the Corps, and current quality-related initiatives would suggest a growing commitment to total quality and to service excellence. The Corps recognizes that its business environment is evolving and that is must now compete with other Federal agencies and private-sector contractors for certain portions of its engineering program. Establishing and maintaining a competitive posture means USACE must continually improve its internal operations to remain a cost-effective choice for its customers. Proof of USACE's commitment can be found in its recently issued quality policy:

> *. . . to deliver excellent engineering and design services and products to customers on schedule and within budget . . .*

Quality and quality management are becoming major issues in a number of USACE's current initiatives. For example, the USACE is currently implementing Total Army Quality (TAQ), which is its internal response to DoD's call for total

quality management (TQM). TAQ is intended to improve USACE's quality management by strengthening its current quality policies, examining alternative methods of incorporating quality into its processes, and developing training and monitoring systems to continually improve its processes at all levels of the organization. A recent memorandum from the Chief of Engineers (see Appendix A) has made it clear that quality initiatives such as TAQ are important to the future success of USACE in its current and expanding markets. At this time, TAQ is not mandatory; however, it is being implemented on a voluntary basis at a number of USACE field activities that expect it to deliver tangible benefits. TAQ, which is prescribed by Army Regulation (AR) 5-1, *Army Management Philosophy*, dated 12 June 1992, is described in further detail in the Army publication *Leadership for Total Army Quality Concept Plan.*

In addition to TAQ, USACE is developing and implementing several automated systems to improve such processes as design reviews and approvals and contractor selection, for example. Further proof of USACE's commitment to quality can be found in its recently released quality doctrine, Engineering Regulation (ER) 1110-1-12, *Engineering and Design Quality Management.* That ER spells out USACE's commitment to quality and its strategy for improving customer service and products for empowering its employees, and for continually improving its operations.

In the field, USACE's engineering organizations are searching for the right blend of new and traditional quality management initiatives that will ultimately improve their operations, engineering products, competitive posture, and customer service. Some field activities have turned to ER 1110-1-12 and TAQ and found that TQM is difficult to implement and does not automatically solve all their problems. What they find lacking is an overall quality management framework and systematic methodology for instituting quality management fundamentals in engineering activities.

One way for USACE to establish that rudimentary quality management system is to adopt the basic elements of proven quality management systems from private industry and/or other government agencies. Experts agree that the fundamental elements and structure of what comprises an acceptable quality management system are well-established, have been used and improved by many successful organizations throughout the world, and fortunately for USACE, have now been standardized and published by the International Organization for Standards as the ISO 9000[1] quality management series.

The ISO 9000[2] quality standards are currently being used by the European Economic Community (EEC) to gauge the acceptability of quality systems of the

[1] ISO is not an acronym for the International Organization for Standards as commonly believed, but rather it simply refers to the Latin prefix "ISO," which means equal.

[2] In the United States, the ISO 9000 standards have been adopted as the American National Standards Institute (ANSI) and the American Society for Quality Control Q90-series standards. Except for some changes in nomenclature, the two sets of quality standards are technically identical. For the sake of simplicity, in this report, we use "ISO 9000" to refer to both sets of recognized quality system standards.

many different companies from different countries that want to do business within the EEC. The ISO 9000 quality system standards merely describe the minimum requirements for an effective and legitimate quality management system within any organization. Those requirements are nothing more than a set of common sense rules and procedures that together govern the way an organization should manage quality so that it produces products or services that meet its customer's demands. ISO 9000's main objective is quality assurance – ***not*** quality control. Compliance with the ISO 9000 quality standards is intended to give an organization's customers a level of assurance that the organization will be capable of consistently delivering quality products and services. The organization does that by continually gauging the compliance of its quality systems against the established ISO 9000 standards, and outside auditors periodically confirm the compliance of their quality management system. The ISO standards do not mandate how an organization should produce its product or services but only what its quality objectives and processes should do.

The use of the ISO 9000 quality standards is currently spreading rapidly throughout the world and is quickly becoming the single world quality management standard. Complying with the ISO 9000 quality standards is a tangible expression of an organization's commitment to quality that rests on internationally recognized quality principles. Should USACE field activities adopt all or a portion of the ISO 9000 or similar type standards? Should USACE field activities become registered under an ISO-type quality system? Should USACE require its contractors to become registered? Those questions are answered in this report.

STUDY APPROACH

The USACE Directorate of Military Programs, Engineering Division, asked Logistics Management Institute to examine existing quality management system standards and to determine whether adopting one like ISO 9000 makes sense for its engineering and design organizations at the division and district levels. The goal is to determine whether ISO-type standards provide a ready mechanism for improving quality management systems internally or for improving the quality, timeliness, and/or costs of the products USACE receives from outside architect-engineering (A-E) contractors.

In this study, we developed a thorough understanding of the ISO 9000 standards, other quality management standards, and USACE's TAQ initiative by interviewing key USACE personnel and industry experts and researching relevant literature and engineering publications. At the same time, we identified and interviewed several private-sector engineering and design firms that had already registered with ISO 9000 so that we could learn why they did so, what benefits they received, what it cost to implement, what barriers they experienced during the process, and what impact they expect their registrations to have on the requirements for quality system registration of their suppliers. We used a survey conducted by Deloitte & Touche, Inc., and the *Quality Systems Update Newsletter* (an ISO 9000 industry publication) in July 1993 to gain needed insights into the community of ISO-registered firms. The survey questionnaire was sent to all

1,679 firms registered in the United States at that time (today, the number exceeds 2,200), and 620 firms responded; about 150 of the responding firms had annual sales in excess of $500 million.

From that independent research and from site visits, we developed a framework for implementing ISO 9000-type quality standards at USACE field activities to determine the impact those standards would have, to evaluate the success of other current quality initiatives, to determine whether those quality initiatives meet the intent of the ISO quality standards, and to assess the extent to which the ISO standards should be adopted. We also examined the possibility and reasonableness of requiring all or some of USACE's suppliers and A-E contractors to be ISO 9000 registered. Registration to ISO 9000 could eventually be required by USACE's customers or it could simply be a way to improve productivity in USACE's engineering and design operations. We identify the likely costs and benefits to USACE along with our recommended course of action and future implementation strategy.

Report Organization

The remainder of this report provides the results of our investigation of the ISO 9000 quality standards and our conclusions and recommendations that follow from those results. Chapter 2 presents an overview of the ISO 9000 standards, describes the reasons most companies in private industry and the design and construction industry in particular choose to become registered, outlines the potential benefits that quality systems and ISO registration bring to an organization, establishes the costs for implementing and maintaining ISO registration, and discusses the major barriers to complying with them. The chapter also shows the major trends occurring in private industry and the impacts those trends have on USACE's quality requirements. For example, the chapter discusses whether USACE customers will eventually require their suppliers to be ISO registered as a prerequisite to doing business and what other engineering and construction firms are doing with respect to ISO registration. In Chapter 3, USACE's current quality systems and initiatives, like TAQ, are examined and compared to the requirements of the ISO 9000 standards to determine whether any satisfy the intent of the ISO quality standards. Finally, in Chapter 4, we present our conclusions about the ISO standards, their impact on USACE operations, and our recommendations for their adoption within USACE.

CHAPTER 2

Quality Management Using the ISO 9000 Standards

INTRODUCTION

Quality, for the most part, is what the customer says it is. To USACE's customers (internal and external), quality means that the engineering and design products they purchase meet their functional and technical requirements and are delivered on schedule and within a competitive cost – USACE's customers want total quality. To ensure they get what they want, customers oftentimes prepare written specifications that detail what the end product should be or should do and sometimes even how it should be done – that activity is called *quality assurance*. The mere fact that those requirements are prepared and written, however, is no guarantee they will be met by the supplier.

Most organizations want to stay in business. To do that in today's customer-focused environment, suppliers and service providers are making sure they understand their customers' requirements and, most importantly, they are doing whatever is necessary to meet them. The quality control mechanisms that organizations impose upon themselves to regulate internal quality and quality processes is known as a *quality management system*. The purpose of quality management is to make sure that the customers' requirements are fully understood, the finished products satisfy those requirements, and the necessary feedback is provided to the customers. In addition to pleasing customers, well-grounded quality management systems usually improve productivity and reduce costs associated with inefficient operations and wasted efforts. The supplier-process-customer model shown in Figure 2-1 illustrates quality systems.

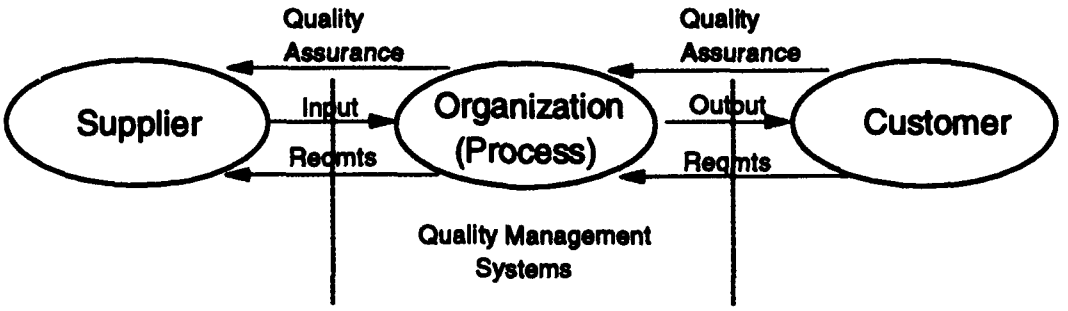


Figure 2-1.
Basic Design of Effective Quality Systems

In the past, customers used quality control specifications (or military quality specifications for DoD organizations) to assure the quality of the products they received from their suppliers. That procedure, however, provided no control over the quality of the process used to deliver the product or service; thus, it did not ensure the quality of future shipments or future services. Those quality control inspections are expensive for both customers and suppliers alike. Then, visionaries like Deming, Juran, Ishakawa, and others claimed that, ultimately, product quality cannot be achieved by inspecting and correcting it into reality but rather, organizations need to focus on understanding and improving the systems and processes that produce the product. A whole new philosophy — total quality management — was born. TQM relieves organizations of the arduous task of quality control and replaces it with a philosophy that the process by which products and services are provided should be right the first time. When quality management is the foundation of the company, quality is built in. However, companies soon learned that TQM could not solve all their problems, was expensive to implement, required unprecedented commitment from all employees, and oftentimes failed for lack of commitment or a poor implementation strategy.

THE ISO 9000 QUALITY STANDARDS

Today, organizations have a new way of initiating quality management into their daily operations by adopting the ISO 9000 quality system standards (see Figure 2-2). *ISO is not TQM, but rather it is a holistic quality management framework that lays out the basics.* The ISO standards are 20 elements of good quality management practice, and any organization that successfully addresses those 20 points has established an acceptable quality management system. The ISO standards are neither product specifications nor technology standards; they *are* essential elements of good management practice and focus on how an organization will consistently deliver quality products and services. Registration from an external auditor confirms that the organization's quality system is consistent with ISO standards.

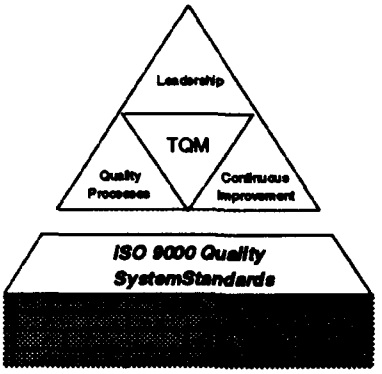


Figure 2-2.
ISO 9000 is the Foundation of Quality Management

The ISO standards themselves are actually quite simple. Used internally as a quality system model, any company that adopts them can safely say that it has a legitimate and documented quality system that is fully implemented and consistently followed. Used for external quality assurance, the standards prove that suppliers' quality systems meet the rigorous requirements of the ISO standards, that the existence of a quality system has been verified by an outside registrar, and therefore, will likely consistently deliver the quality product customers want. Basically, the ISO standards require an organization to put into place a quality management system that does the following:

- ***Documents what the organization does.*** The organization must develop and maintain documented procedures that show what processes are used to deliver its products or services and that demonstrate how quality is ensured and the customer's requirements are met. Documentation provides the needed evidence that all procedures that affect the quality of a product have been thoroughly addressed and planned (later, the documentation will be used as an integral part of the audit process). The documentation should include a quality manual that serves as a blueprint for the quality management system and lower level documentation for describing processes and procedures (only those procedures directly affecting product quality need to be documented).

- ***Demonstrates the organization actually does what is documented.*** The organization must prove (usually verified through observation) that the personnel or systems responsible for executing those documented procedures are doing so. Auditors will look for 3 - 6 months of evidence that the organization has been following its documented procedures.

- ***Measures and keeps accurate records of the work that was performed.*** Organizations must also prove that the records are legitimate and that quality has been part of the business over time. Part of that "burden of proof" rests with effectively recording elements of the business affecting the quality of the product.

- ***Evaluates and analyzes the results.*** The organization must establish a system for checking how well the product or service performs with respect to those documented procedures and customer requirements. Results from that analysis can trigger corrective actions.

- ***Corrects system deficiencies and continually improves.*** The organization must have a system that ensures problems are resolved and corrective action is taken. When warranted, corrective action should update existing procedures and the requisite documentation (e.g., continuous improvement). Continuous improvement and better processes and procedures are areas where USACE's TAQ and reengineering efforts can help.

The ISO quality standards are flexible enough to be used by almost every industry and enterprise in the private or public sector. As a result, they are having a significant impact on international trade and, to date, almost all of the

industrialized world (60 countries) has adopted them as their national standards (see Figure 2-3). Regional trading groups such as the European Economic Community (EEC) are using the ISO standards to establish uniform systems for product standards, product certification, or quality system registration. Although no formal agreements have yet been adopted, the ISO standards are being considered by other trading partnerships such as the North American Free Trade Agreement (NAFTA) and the General Agreement on Tariffs and Trade (GATT).

Figure 2-3.
Registered Companies in the World Today

ISO 9000 Architecture

The basic architecture of the ISO 9000 standards is a related set of five individual documents. Three of them, ISO 9001, ISO 9002, and ISO 9003, are the core quality conformance documents that external entities use to verify the existence of a quality system and that are used in contractual agreements. An organization registers to the ISO standard that most closely relates to the scope of its primary business processes. (Additional material on selecting the appropriate standard is included in the next subsection of this chapter.) The other two individual documents, ISO 9000 and ISO 9004, are supporting guidelines. The five documents are as follows:

- **ISO 9000** — *Quality Management and Quality Assurance Standards: Guidelines for Selection and Use.* This document provides users with an overview of the

ISO standards, key definitions, concepts, and guidelines for selection of either the ISO 9001, 9002, or 9003 quality assurance models.

- **ISO 9001** – *Quality Systems – Model for Quality Assurance in Design/ Development, Production, Installation, and Servicing.* As the name implies, this document is a quality assurance standard that is used to ensure conformance during design/development, production, installation, and servicing. It has been developed for organizations with a full range of activities that need to be involved in the quality system.

- **ISO 9002** – *Quality Systems – Model for Quality Assurance in Production and Installation.* This standard is used when only production and installation functions are to be monitored.

- **ISO 9003** – *Quality Systems – Model for Quality Assurance in Final Inspection and Test.* This document is a less restrictive quality standard that covers only the inspection and testing of the organization's product.

- **ISO 9004** – *Quality Management and Quality System Elements Guidelines.* This document is not a standard but rather a guideline for developing an internal quality system to meet either the ISO 9001, 9002, or 9003 standards.

The ISO 9000 standards cover everything affecting quality, but they do not proscribe the methods, systems, or technology needed to perform quality management. Rather, the standards establish benchmarks that indicate minimum levels of acceptance. Table 2-1 shows the 20 quality standards of ISO 9001, the most comprehensive of the three core quality conformance documents, along with a cross-reference to ISO 9002 and 9003. The actual ISO 9001 standards have been reproduced in Appendix B.

Selecting the Appropriate ISO Standard

In selecting which of the quality assurance models (9001, 9002, or 9003) to adopt, most organizations simply refer to the guidance found in the ISO 9000 standard, which requires "systematic consideration" of the following six factors:

- ***Design process complexity.*** How difficult is the design and/or preliminary development of the product or service?

- ***Design maturity.*** Is the product developed uniquely every time?

- ***Production process complexity.*** How complex is the process for developing the product or service?

- ***Product or service characteristics.*** How complex is the product or service and how critical are the interrelated characteristics of the product to its performance?

- ***Product or service safety.*** How costly are product failures?
- ***Economics.*** How costly are the preceding factors relative to the costs of nonconforming products?

Table 2-1.
ISO 9001 Quality Elements and Cross-Reference

Quality system element (ISO 9004 description)	Section of document		
	ISO 9001	ISO 9002	ISO 9003
Management Responsibility	4.1	4.1	4.1
Quality System (quality system principles)	4.2	4.2	4.2
Contract Review (quality in marketing)	4.3	4.3	—
Design Control (quality in specification and design)	4.4	—	—
Document Control (quality documentation and records)	4.5	4.4	4.3
Purchasing (quality in procurement)	4.6	4.5	—
Purchaser-Supplied Product	4.7	4.6	—
Product Identification and Traceability (material control and traceability)	4.8	4.7	4.4
Process Control (quality in production and control of production)	4.9	4.8	—
Inspection and Testing (product verification)	4.1	4.9	4.5
Inspection, Measuring, and Test Equipment (control of measuring and test equipment)	4.11	4.1	4.6
Inspection and Test Status (control of verification status)	4.12	4.11	4.7
Control of Nonconforming Product (nonconformity)	4.13	4.12	4.8
Corrective Action	4.14	4.13	—
Handling, Storage, Packaging, and Delivery (handling and postproduction functions)	4.15	4.14	4.9
Quality Records	4.16	4.15	4.1
Internal Quality Audits (auditing the quality system)	4.17	4.16	—
Training (personnel)	4.18	4.17	4.11
Servicing (after-sales servicing)	4.19	—	—
Statistical Techniques (use of statistical methods)	4.2	4.18	4.12

Because of the limited nature of ISO 9003, organizations rarely select it. Few organizations have much to gain by merely verifying the acceptability of their quality processes for inspection and testing operations. Therefore, the real choice for most organizations wishing to adopt an ISO quality model is between ISO 9001 and ISO 9002. The major difference between those two standards is in the treatment of the design control (4.4) and servicing (4.19) standards — ISO 9001 includes product design and servicing and ISO 9002 does

not. In deciding which standard to select, the organization must determine the extent to which the design of the product or service affects the quality and performance of the product. If the organization has complete control over the design of the product and that control is a major factor in ensuring product quality, then that organization should choose registration under ISO 9001; otherwise, ISO 9002 would be the correct choice.

In the engineering industry, "designs" refer to end products and the ISO 9001 "design control" standard is commonly defined as "design planning," which requires ensuring the product (engineering plans or designs) is delivered on schedule, within budget, and meets the customer's requirements. Since design planning is critical to the quality of the product, so far all engineering firms have chosen to adopt the ISO 9001 quality assurance model.

The Relationship of ISO 9000 and Total Quality Management

One of ISO's greatest strengths is its versatility, so its criteria for acceptability fall short of some world-class organizations' quality system needs. The ISO standards do not necessarily define an *exceptional* quality management system or even that TQM exists. Actually, the quality system defined by ISO 9000 falls short of what would be considered a bona fide TQM system and only begins to approach the criteria established by the Malcolm Baldridge National Quality Award (MBNQA) or the Presidential Award for Quality. Each establishes legitimate quality management systems, but where MBNQA and the Presidential Award strive for world-class quality systems (i.e., "the best of the best"), the ISO standards only demand that the minimal elements of total quality systems exist. ISO 9000 does not gauge product quality, satisfied customers, and continuous improvements as does the MBNQA, for example. On the other hand, successfully implementing TQM would be difficult without first meeting the quality system elements of ISO 9000 since ISO standards prescribe the fundamentals.

Many companies are choosing to use the ISO 9000 standards as a way to put those quality system fundamentals in place and then to implement TQM to further improve processes and perhaps even strive for the world-class quality embodied in MBNQA, for example. Organizations that already have successful TQM programs however, may find ISO standards redundant. For them, the ISO 9000 standards can be considered as the basic components of a much broader quality management system. Viewed on a continuum, the relationship of previous quality control specification, ISO standards, TQM, and today's top-quality awards would look like that shown in Figure 2-4.

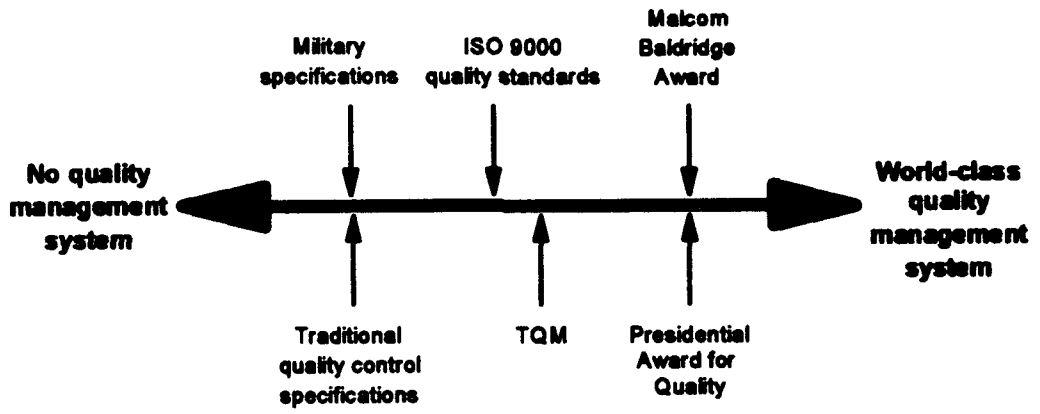


Figure 2-4.
Quality Management Continuum

Options for Adopting the Standards

Organizations choosing to use the ISO standards for improving their internal quality systems or as quality assurance mechanisms have several options for adopting them. Most companies whose customers are requiring them to register are entering into contractual obligations that make their ISO registrations mandatory. Those firms have no choice but to register to one of the ISO 9000 series standards. However, some companies that simply want to improve their internal quality management systems are using the ISO standards as a model or recipe for successfully establishing the basic elements of quality management systems. Those companies are adopting the basic premises from the ISO standards (typically using ISO 9004) and incorporating them into their operations and procedures. Because they are voluntarily adopting the standards, they can use whatever elements they feel would be most beneficial to their companies and ignore the ones that are too expensive or difficult to follow. However, since the ISO standards prescribe the minimal elements of quality management, adopting only selective elements breaks the essential balance and typically what is left is an incomplete quality system with only incremental benefits.

Companies that choose to self-regulate to the ISO standards rather than paying for the external verification of an outside auditor may perform the audits internally as though an outside auditor were involved. That way, they are able to show their customers that they have fully implemented a quality system that meets the ISO requirements. For some companies, such an approach may be all that is needed to realize the benefits. Others, however, prefer to take the next step and voluntarily become registered. They have found that any approach involving self-regulation requires too much discipline to remain committed to their objectives and that the registration itself provides benefits and external perceptions of their quality system that self-regulation does not.

Registering a Quality System

Those organizations that have chosen to register voluntarily or have been contractually required to register have found that the ISO 9000 standards are nothing more than generic guidelines for what constitutes an acceptable quality system. Registration to the ISO 9000 quality system standards means that an organization has met those minimal requirements and that an outside, independent auditor, known as an ISO quality system *registrar*, has examined the organization's quality system and found that it complies with its interpretation of the ISO standards. The audit seeks to ensure that a quality system exists, that all elements of the ISO standards have been adequately addressed, that the elements are sufficiently documented, that processes are consistently implemented in accordance with that documentation, and that adequate records are kept. The auditors (sometimes called assessors), evaluate the organization's quality system, and if it meets all elements satisfactorily, the company is granted a registration to the ISO standard selected (ISO 9001, 9002, or 9003). In some cases, auditors will grant conditional registrations pending future correction of deficiencies. Usually, the next reassessment audit will be used to verify the corrections. Registration does not, however, guarantee the quality of the product; it simply means that high-quality processes that deliver that product are in place.

A successful organization receives a certificate, the registration is published in a register available to the public, and the organization is permitted to use its registrar's logo in its marketing and to display it in its advertising, stationery, and packaging as evidence that its quality system meets the requirements of the ISO standards. Registrars are accredited in the United States through a national central authority that sanctions each registrar's ability to bestow registrations. Many U.S. registrars have entered into agreements with European counterparts so that registrations in this country are also valid in the worldwide community.

Registration to ISO is site-specific, so organizations with many sites must register each site separately. Once a site becomes registered, that registration is valid indefinitely as long as it continues to pass periodic surveillance audits. Organizations that fail any reassessment may lose their registration and the privileges that go with it. Those organizations may correct those deficiencies and reapply for registration.

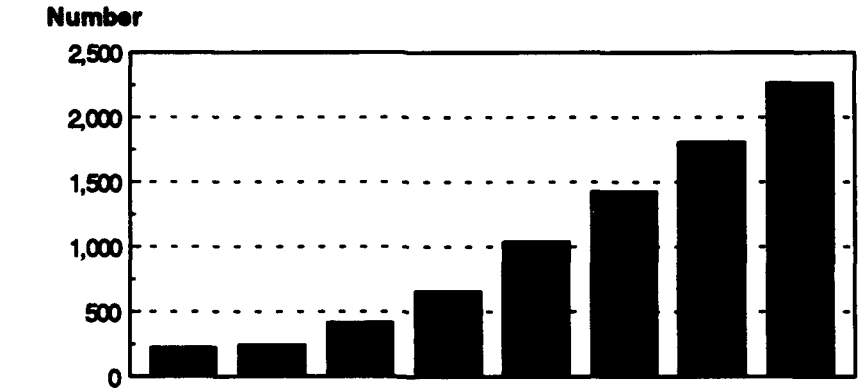
History and Growth of the ISO Standards

In 1987, the ISO 9000 standards were written by a worldwide delegation to pull together and standardize all the different quality system standards found in different countries around the world. Tracing the origins of every separate standard would be difficult; however, we can safely say that the ISO standards have a basis in the U.S. DoD MIL-Q-9858 military quality management program established in 1959. Later, in 1968, NATO adopted the basic elements of the

MIL-Q standards in their AQAP series of quality standards. A decade later, the British developed the first commercial quality assurance standards, the British Standard 5750, from the NATO standards. A technical committee of the International Organization for Standards, a multinational body represented in the United States by ANSI, used the British standards as the basis for the ISO 9000 standards.

The multinational body agreed at the time the ISO standards were being developed, that they would be updated every 5 years. Although the first full revision is not expected until 1996, the technical committee has already developed a plan for the future use of the ISO standards through the year 2000.

The explosive growth of ISO 9000 registration in this country can be traced to the regulatory requirements for quality system registration imposed by the EEC. Since Europe is one of this country's largest export markets, it is easy to understand why many U.S. industries are so rapidly registering to the ISO 9000 standards. Quite simply, for certain industries, if a company wants to do business in the European market, ISO 9000 registration is mandatory. While contractually mandatory registrations may have been the catalyst to adopting ISO in the United States, today, growth has exceeded that primary reason. Those U.S. firms that have already become certified are finding that ISO registration is a good way to ensure that their suppliers have suitable quality systems in place; as a result, they are requiring their suppliers to become registered as well, which explains the rapid growth in U.S. registered firms over the past 5 years. To date, more than 2,200 firms are registered to ISO 9000 standards, which is about four times as many as a year ago. Figure 2-5 shows the growth of ISO registration in all industries in the United States by quarter since the beginning of 1992.



Quarter	1- 1992	2- 1992	3- 1992	4- 1992	1- 1993	2- 1993	3- 1993	4- 1993
# Firms	222	241	413	654	1035	1420	1804	2260

Figure 2-5.
Growth of ISO Registration in the United States

To date, only a handful of firms in the design and construction industry have become registered to the ISO 9000 standards. For those firms, the force impelling that registration has been the demand from the international marketplace. Despite the relatively few design and construction firms currently registered to ISO 9000, interest in the standards is growing rapidly. More and more firms have to respond to requests for proposals (RFPs) that include statements addressing ISO compliance. For example, one registered U.S. firm recently responded (before it was registered) to an RFP that called for ". . . a quality system in place like ISO 9000." While ISO registration is not yet required by building owners, the message is becoming quite clear: many customers will soon be doing business only with design and construction firms that deliver quality products, and ISO 9000 will be used to verify that quality management practices are being followed. In recognition of that trend, many firms in the industry are rushing to learn more about ISO, and when they learn of the many benefits of adopting the ISO philosophy, they seek registration. An informal survey of about 100 engineering and construction firms showed that only one was ISO-registered, but almost 50 others were actively pursuing registration and all others were in the process of learning more about ISO.

REASONS TO REGISTER

In addition to the demands of the EEC, organizations are choosing to register for other reasons. Most organizations that are registering to any one of the ISO standards are doing so for three major reasons: customer demands, improved quality systems, and competitive advantage. Figure 2-6 illustrates the six top reasons from Deloitte & Touche and the *Quality Systems Update Newsletter* industry survey.

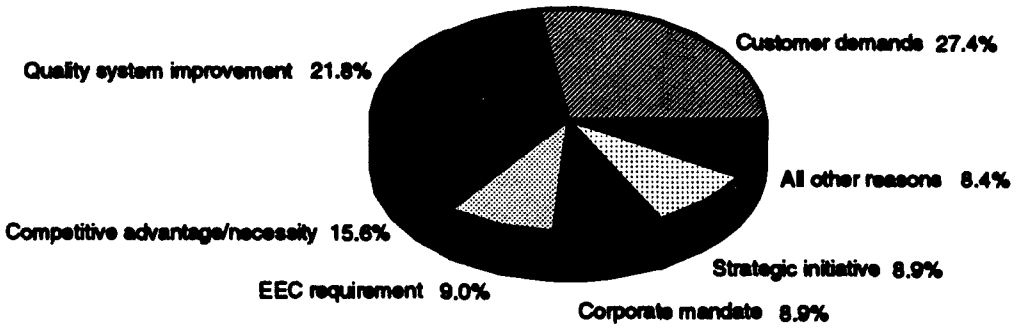


Figure 2-6.
Primary Reasons to Register

The three principal reasons for U.S. company registration are as follows:

- *Customer demands.* For the most part, U.S. companies are registering because their customers demand it. While 9.0 percent of the respondents said they registered because they were doing business in the EEC, more than 27 percent of the respondents say that their primary reason for registering was that customers (other than those in the EEC) said they must. Many of the customers that made those demands are companies that already registered themselves and have begun basing the selection of their suppliers and contractors on ISO quality system compliance. Almost 80 percent of the registered firms require or will require their subcontractors to register.

- *Quality system improvement.* According to the survey, nearly 22 percent of the registered companies had no external pressures to register but decided to seek ISO registration because they wanted to establish stronger quality foundations within their organizations. Their goals are to improve productivity and costs and/or to enhance customer service and customer satisfaction. For many, TQM programs have failed because of fundamental flaws in their implementation. By using the ISO 9000 quality system standards as their model, they are putting the fundamental quality system ingredients in place and establishing a solid foundation. From there, some hope to build even stronger quality programs using TQM, MBNQA, and/or other quality system criteria.

- *Competitive advantage/necessity.* Almost 16 percent of the registered companies in this country became registered because they want to use their ISO registrations much the same as those who seek the MBNQA. They want to become some of the first in their respective industries to become registered and then they want to use those registrations in their marketing and advertising strategies. They recognize the importance of demonstrating to their customers that they are aggressively solving quality shortfall problems. Their goal is to obtain higher sales because of their established quality positions. Similarly, others are finding that the rest of their industry is registering and they too must be registered so that they will not be closed out of their respective markets. Nearly all registered firms from the survey indicate that they will use their registrations in their marketing and public relation strategies.

Informally, we found that the reasons engineering and construction firms in this country that are now registered or are seeking registration adopted the ISO standards varied as widely as the U.S. marketplace as a whole. Quality system improvements, customer requirements, corporate mandates, and competitive strategies were the primary reasons they registered. Registered firms found that a growing number of their clients are "encouraging" ISO registration as proof that legitimate quality systems exist and that the company will be capable of delivering the quality product and service as promised. However, traced back to their underlying causes, the requirements of the international marketplace seemed to initiate their motives of pursuing registration.

TYPICAL COST OF REGISTRATION

The cost to adopt the ISO 9000 standards and/or become registered is strongly dependent on the quality systems that the organization currently has in place and can vary greatly from one organization to the next. For example, an organization that already has good documentation of its processes and procedures will invest much less effort into complying with the ISO requirements than an organization that has no such documentation. Most companies will need 6 months to a year to prepare for the initial registration audit. In addition to the up-front implementation cost, organizations that decide to register will experience yearly on-going costs to maintain ISO compliance.

Costs to adopt the ISO 9000 requirements fall into six categories. For most companies, the largest cost will probably be for interpreting the ISO standards and creating those procedures necessary to comply with the ISO requirements. The second largest cost will probably be for developing the required documentation, including the quality manual, operating procedures, and work instructions if necessary. The third cost category is for training; organizations will want to provide 2 to 4 hours of basic ISO training to everyone in the organization and perhaps 40 to 80 hours of training for several persons who will be responsible for internal audits of the quality system. The basic training, while not actually required by the ISO, is a very good idea, since it will help educate personnel who will be responsible for the program's success and will help alleviate fears that ISO standards will dramatically change peoples' jobs. The fourth cost category, and perhaps the smallest, includes the time that the organization's leadership will need to manage the program's implementation efforts, hold meetings with the registrar and staff, and perform internal audits. The fifth cost category consists of external expenses for consultants and perhaps preliminary audits. Not all organizations choose to use consultants, and many perform all of their preliminary audits in house. The final category of costs includes those costs for the actual registration, which typically entails a flat fee paid to an external registrar. The Deloitte & Touche/*Quality Systems Update Newsletter* survey shows that medium-to-large companies ($50 million to $500 million annual revenues) spend an average of $150,000 to $350,000 on those internal and external compliance costs.

According to the survey, all companies that choose to register will spend another $20,000 to $40,000 on the registration itself. The actual costs of the registration will depend largely on what the scope of registration is and how many audits are required before the organization meets the registrar's requirements. Therefore, the total costs of implementing and registering under ISO 9000 will range between $170,000 and $390,000. Most companies can expect to pay around 10 percent of the total implementation cost for actual registration. While that cost seems high, nearly all companies that have registered under the ISO standards, regardless of whether they were externally or internally motivated to do so, say that it is worth the time, effort, and cost. Nearly all the organizations surveyed experienced quantifiable yearly savings as a direct result of the registration. Those and other benefits will be discussed in the following section.

The ISO-related costs do not end once an organization registers. Since the ISO 9000 is not an award or a recognition program, the organization must continually prove itself to registrars. Depending on the initial audit, an annual or biannual reassessment of the organization's quality system will be necessary. Reassessment audits will cost between $3,000 and $6,000. Also, the ISO standards themselves require some on-going costs for full-time management of the program and periodic internal audits of the organization's quality system. The engineering companies we interviewed suggested that a full-time person responsible for quality programs (in which ISO is a part) plus half of a full-time equivalent staff member for conducting the ISO-required internal audits are needed to meet the ISO standards.

BENEFITS OF REGISTRATION

Most companies adopt or become registered to the ISO standards because they expect tangible benefits that can be categorized as internal or external. Figure 2-7 shows the most important internal benefits: better documentation, greater awareness of quality management, and positive cultural change topped the survey and accounted for 73 percent of the industry responses. While not nearly as significant as the others, nearly 10 percent of the respondents said increased operational efficiency and productivity were the greatest benefits of ISO registration. The most significant external benefits of ISO registration, shown in Figure 2-8, were a higher perceived quality, improved customer satisfaction, and increased competitive advantage. Nearly 82 percent of the respondents picked one of those top three external benefits. While still a quantifiable benefit, only 8.5 percent of the respondents said reducing customer quality audits was their biggest reason for becoming registered to the ISO quality assurance standards.

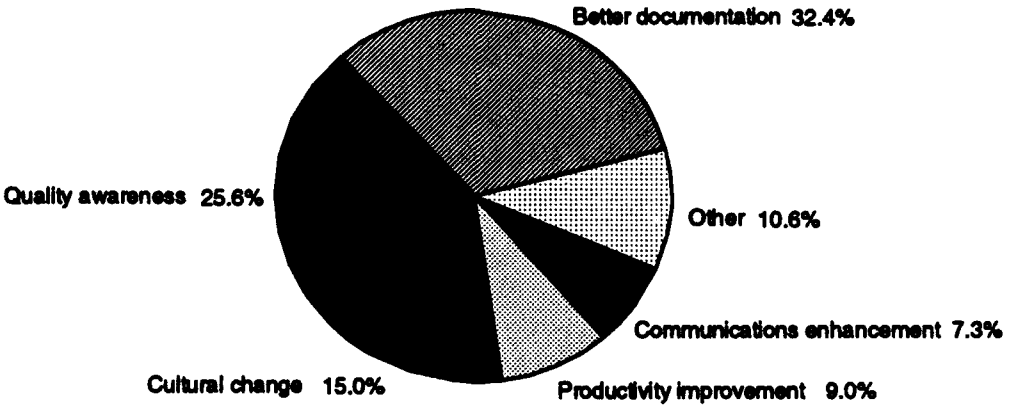


Figure 2-7.
Most Important Internal Benefits

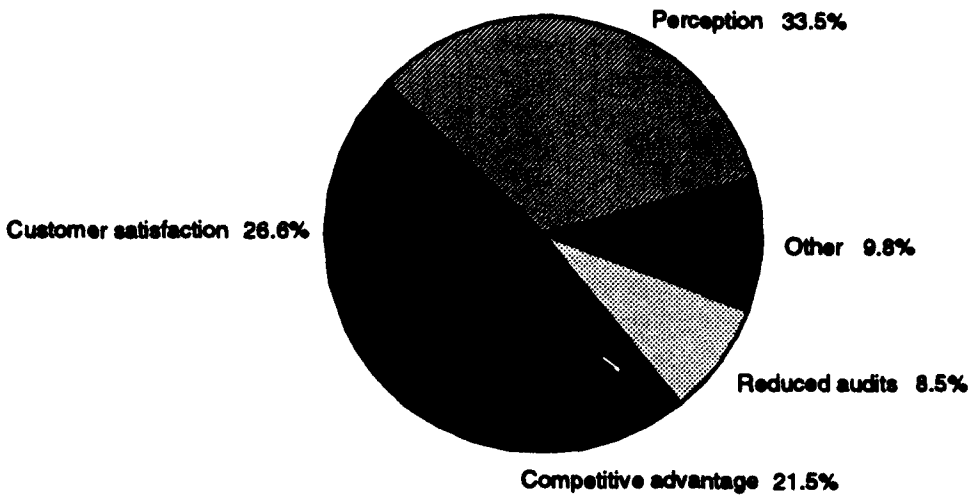


Figure 2-8.
Most Important External Benefits

Nearly all registered companies — even those that were forced to register — said they experienced definite quantifiable benefits from adopting the standards. Payback for about half the companies came in about 3 years, but 30 percent were paid back in 12 months or less. Our interviews in the engineering industry suggest that previous inefficiencies, lost design effort, and lack of commitment to quality meant that improvement resulting from ISO would result in investment payback in less than 1 year. So far, the engineering staffs in those organizations are highly receptive to the changes that ISO 9000 encourages.

IMPLEMENTATION BARRIERS

According to the survey of registered firms (see Figure 2-9), the most difficult aspect of meeting the ISO requirements is developing the necessary ISO-compliant procedures and documenting those procedures. Nearly 40 percent said that those were the greatest barriers to ISO registration. The next most cited barrier to successful implementation was inadequate management commitment. Overall, nearly 10 percent of the respondents had leadership difficulties, but management commitment was a greater problem for large companies than for small ones. Surprisingly, a relatively small percentage (about 12 percent) of the firms already registered to the ISO standards say that employee resistance and employee training were serious barriers to implementing the ISO standards.

In the design and construction firms we interviewed, developing the ISO procedures and the required registration and getting and keeping management's commitment to the program were universally the greatest difficulties in becoming registered.

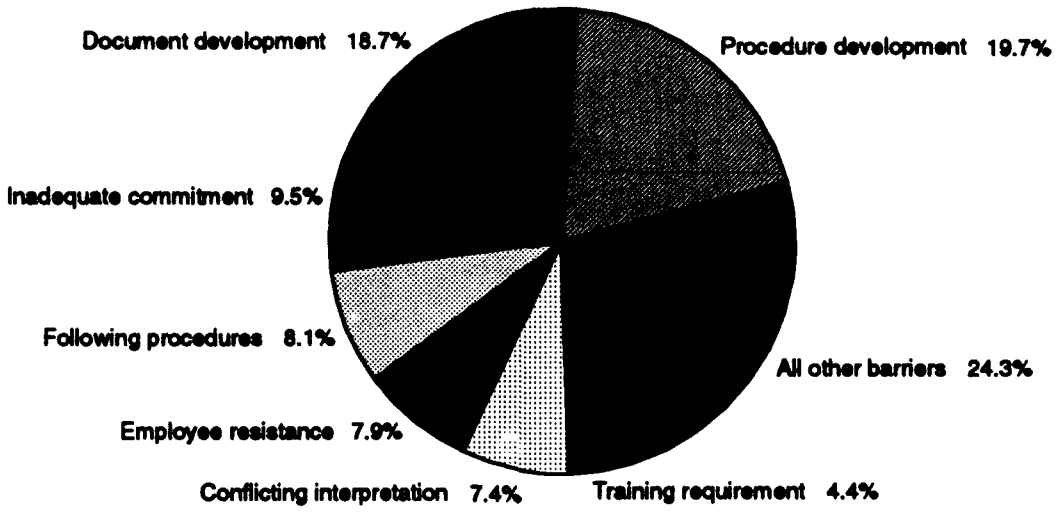


Figure 2-9.
Barriers to ISO Registration

USACE CUSTOMERS

As discussed earlier, customer demand is a fundamental reason for an organization to decide to register to ISO. Sometimes, it makes registration mandatory. All the U.S. firms doing business in the EEC have experienced that requirement, and to avoid the risk of losing their European business bases, they are quickly moving to register under one of the ISO quality standards. The same phenomenon is true in doing business with U.S. companies; firms that are already registered recognize the value that adopting the basic tenets of ISO standards brings to the quality of their products. Therefore, registered U.S. companies are now requiring their suppliers in the United States to become registered too. Such requirements are reaching down several tiers into the customer-supplier chains.

So far, none of USACE's current customers has instituted ISO-only requirements in its source selection criteria or as a contractual requirement. At this time, none anticipate doing so in the future. If USACE anticipated that its primary customers would begin requiring ISO registration for all their suppliers, then it would be obvious to conclude that USACE should become registered as a means to stay in business.

Notwithstanding, some evidence indicates that the Federal government is taking some actions on the ISO standards. A new Federal directive published in the October 26, 1993 *Federal Register* directs Federal agencies to use international standards such as the ISO 9000 quality assurance standards whenever possible in procurement and regulatory activities. The result may be that companies registered to ISO may have a competitive advantage in obtaining future government contracts. The directive states: *"International standards should be considered in procurement and regulatory applications in the interests of promoting trade and implementing the provisions of the agreement on technical barriers to trade and the agreement on government procurement."*

Several government agencies, including DoD, the Department of Energy, General Services Administration, and NASA already are using or are considering the use of ISO standards. In DoD, a multi-service task force has been assembled to look at the ISO standards and determine their impact on military contracting. The draft report, which is due in April of 1994, is expected to give contracting officers the flexibility to include ISO 9000 provisions in future contracts. For the time being, ISO standards are likely to be used to supplement, but not replace, current military specifications in contractual requirements. If contracting officers are allowed to do so, other DoD agencies and USACE will be able to include the ISO standards in contractual relationships to verify that quality systems of their suppliers meet the ISO standards. The forthcoming directives will certainly increase the spread of ISO registration to even more U.S. firms.

CHAPTER 3

Quality Initiatives in the USACE Today

USACE QUALITY MANAGEMENT INITIATIVES

The quality of its products has always played a central role in USACE's approach to its engineering and design services. At its core, the integrity of dams, buildings, bridges, plants, and other facilities is of paramount concern in protecting the public safety. Engineers and architects must ensure that each design not only complies with appropriate building codes and industry standards but also satisfies the customer's technical needs. An elaborate set of criteria is managed by USACE to ensure that its designers are kept up to date and follow current requirements for engineering and design services. The USACE criteria system is the cornerstone of the USACE quality management system.

A number of improvements to the USACE quality-related policies and procedures have been initiated over the past years to further improve technical product quality and quality control, and to address customer satisfaction. At the forefront, Total Army Quality (TAQ) is USACE's response to the Army's and DoD's calls for TQM. TAQ will be discussed in the following sections. The following are among some of the other significant quality steps USACE has undertaken:

- The Corps established the A-E Contract Administration and Support System (ACASS), an automated system for recording A-E contractor performance on specific contracts, and it oversees the ACASS for DoD. USACE districts and other Defense agencies are required to query ACASS before selecting A-E firms for contracts to verify that the past performance of those firms has been satisfactory. In the future, all Federal agencies may be required to use ACASS.

- The National Institute of Building Sciences began publishing in its Construction Criteria Base (CCB) guide specifications and other criteria furnished quarterly by USACE, other construction agencies, and industry standards groups. The quarterly updates using compact disk, read-only memory technology ensure that the latest criteria are available for subscribers, including all Corps districts and A-E firms. For convenience, many other types of information, such as design manuals and military handbooks are included in the CCB to assist designers in preparing plans and tailoring specifications for each project and keeping abreast of criteria and technology changes.

- When designers encounter technical problems that may have Corps-wide interest and could affect current criteria, updates to the criteria are

published in the CCB. Thus, USACE has an effective quality control process to report such problems, ensure they are channeled to the appropriate technical experts, and see that they are resolved expeditiously. Results are published in the *Engineering Improvement Recommendation System Bulletin* – better known as the *EIRS Bulletin.*

- The Automated Review Management System (ARMS) has recently been introduced by USACE as another significant quality assurance improvement to help clarify, track, and record design comments made by customers and in-house review teams. Designs cannot be approved for construction until all review comments are resolved satisfactorily. An additional ARMS feature allows design managers to review and analyze the nature of comments and detect trends with certain technical areas, A-E firms, or customer concerns. ARMS has imposed greater discipline on the design review process and is an important step forward for USACE quality management systems.

USACE Total Quality Initiatives

In general, USACE customers regard the technical quality of its engineering and design products as superior. Their expectations are changing, however, and while delivery of a technically superior product is assumed, those products are also expected to be delivered on schedule and within a reasonably budgeted dollar amount. Moreover, Army customers are beginning to examine choices for selecting alternative design agents when their expectations of Corps quality are not being met. We encountered at least two customers that are actively considering alternatives based on recent unsatisfactory experience with USACE costs, responsiveness, products, and level of service.

A reduction in military workload, the reality of downsizing, and the threat of closing districts and divisions have caused USACE to begin examining its quality processes. Efforts to streamline its A-E contracting process, one of the more notorious stumbling blocks in responding to customers, have resulted in establishing duration standards for contractor selection, negotiation, and award. Headquarters, USACE, has also published planning and design cost targets that establish rates that customers should expect to pay for design services. Those rates vary by project size and complexity and are being used to gauge individual district and division cost performance. A comprehensive review of the manpower model used to establish manpower requirements on the basis of projected workload is also being conducted. Other initiatives, including the examination of overhead costs, review processes, organization and staffing requirements, and customer planning deficiencies, are part of this comprehensive quality review initiative. In summary, some important and far-reaching steps are being taken to examine key elements of the USACE engineering and design total quality process.

Engineering Regulation 1110-1-12, *Engineering and Design Quality Management,* CEMP-ES/CECW-EP, dated 1 June 1993, is another important milestone that USACE has reached in its quest for total quality. That document provides

general policy and principles for improving the quality of engineering and design services and products, and serves as a guideline for quality procedures, practices, and tools. Within the general precepts of total quality management, and in line with the philosophy of ISO 9000, the engineering regulation seeks to focus on customer requirements, strive for continuous process improvement, and empower people with the responsibility and accountability to achieve excellence within their full potential. Among the many facets of engineering and design quality identified in ER 1110-1-12, a few of the more significant are as follows:

- Customer requirements must be thoroughly understood and documented at project inception; otherwise, delays and false starts can be expected.
- Coordination among all engineering and design participants is vital, and the responsibilities of the customer, project manager, technical manager, and designer must be carefully defined. The role of the designer during the construction phase is also highlighted.
- Project management plans and quality control plans are essential tools that define how quality will be incorporated into each USACE project.
- The process of quality verification through a system of reviews, checklists, and record keeping (ARMS) is necessary for proper quality discipline.
- Accurate and timely designer evaluations are important to ensure that future designer selections consider past performance.
- A lessons-learned feedback system that collects information, is integrated with design criteria management, and is readily available to all designers is to be implemented by each USACE command.
- Effective partnering arrangements are needed among professionals as well as among all participants in the engineering and design process.

This engineering and design quality-management regulation provides a needed compendium of many quality-management requirements that previously have been promulgated in a piecemeal fashion. The document should not, however, be viewed as comprehensive guidance for total quality engineering and design management. While it acknowledges in its policy section that responsiveness and cost are important ingredients of the total quality process, it fails to deal with the specifics of those total quality dimensions in serious detail. The primary focus of ER 1110-1-12 rests in the more traditional USACE approach to quality through the technical dimension only.

TOTAL ARMY QUALITY

Army Regulation 5-1, *Army Management Philosophy*, dated 12 June 1992, established TAQ as the Army's management philosophy. It provides the

methodology, tools, and techniques to perform the systematic analyses of organizations, businesses, and work processes to achieve the requisite improvements. The method for implementing TAQ is described in the Army guidance *Leadership for Total Army Quality Concept Plan;* the plan was initially developed in February 1993 and is now being refined. The plan is based upon the vision statement shown in Figure 3-1.

Vision Statement

America's Army is a partner in freedom which the Nation can count on. . . . A total force trained and ready to fight. . . serving our Nation at home and abroad. . . . A strategic force capable of decisive victory.

Source: AR 5-1.

Figure 3-1.
Army Vision Statement

The plan is structured to provide sufficient detail for consistency in the Army's overall approach while giving commanders maximum flexibility in developing an implementation plan for their organizations. It has been organized into four phases — awareness, assessment, team building, and action. Patterned along the lines of other TQM concepts, TAQ recommends establishing top and middle management policy and advisory committees with workers organized into process action teams to tackle specific process improvement initiatives.

The customer must remain at center stage in any quality management endeavor, and the Army has defined the nation as its ultimate external customer and the soldier as the ultimate internal customer. The mission assigned to USACE to support both Civil Works Programs and Military Programs can easily relate to and identify both the nation and the soldier as customers of its diverse services. In his memorandum of 22 April 1993 (see Appendix A), LTG Williams, Commander, USACE, announced his full support for TAQ and encouraged all USACE commanders to adopt the concept and determine how best to implement it within their respective organizations.

Most USACE organizations have made some effort to adopt TAQ, albeit to varying degrees. Some Corps commands had recognized the benefits of TQM before the Army formally established TAQ and were making independent headway toward continuous process improvement. One district had embarked upon an extensive employee training program and was anticipating improvements in its many processes. Several districts have assigned key senior managers to

oversee TAQ implementation on a full-time basis, and executive steering committees have been activated. We found that process action teams have also been formed and a number of improvements have already been identified and implemented. Our limited sample of visits with three districts and discussion with two others indicate that TAQ is being well received within those USACE organizations adopting it. During those visits we also found that some efforts lacked continuity and that success may be limited because of the absence of an overall framework and criteria for measuring success.

In February 1994, Headquarters, USACE, established a Quality Council, primarily to oversee quality initiatives in the Headquarters organization. The Council's functions are expected to be expanded to provide guidance and support to all USACE TAQ and other quality initiatives.

COMPLIANCE WITH QUALITY SYSTEM STANDARDS

To assess how difficult the task might be if USACE were to adopt and comply with the ISO 9000 quality system standards, we first translated each of the ISO 9001 standards into terms applicable to USACE field organizations. We then developed a set of guidelines for use in checking conformity to each of ISO 9001's 20 quality system elements. Appendix C summarizes those standards and guidelines. Additional work is expected to be necessary to refine those guidelines for general use and for tailoring to each field organization, consistent with the opinions of auditors and registrars.

The standards and guidelines in Appendix C appear quite extensive, but we believe the USACE districts we visited are fundamentally sound with basic quality management elements in place (although some improvements in this area are warranted). Imposing the requisites of quality processes embedded in the ISO 9000 standards on districts is clearly a management challenge rather than a technical one. Nevertheless, considerable work will be needed to comply with ISO 9000. For example, the standards require significant documentation of engineering and design processes. Document control, records management, training, and customer requirements will need serious attention, and a major effort (and cost) will be necessary to develop and implement a structured implementation program. Finally, the entire quality management concept under ISO 9000 standards must be orchestrated in a comprehensive and coordinated framework of planning with training and documentation as its pivotal thrusts.

To be able to "say what we do" (a first step toward ISO 9000 registration) requires the preparation of extensive documentation describing each major engineering process affecting product quality. Auditors must be able to understand the processes to verify that "we do what we say" (the second step of ISO 9000 standards compliance). Most USACE processes are broadly described in directives and regulations, but local process documentation is inadequate. Based on experiences of private-sector companies, having processes accurately documented not only improves productivity, it also reduces uncertainty and, thus, enhances employee morale. Developing proper documentation will be a major

effort, but for those districts that decide to pursue compliance with ISO 9000 standards, their experience in preparing the documentation will reduce the effort for others that follow.

The USACE field activities generally believe that their quality management systems are adequate; however, we found that their control of some of the processes and procedures that produce their engineering and design products are not compliant with an ISO quality management system and, in most cases, needs improvement. Their current quality systems are oriented more toward product – not process – quality. The issues of cost containment and schedule, for example, have been less important than the technical capability of the finished products.

We found that too many process activities are individual-dependent, and when key persons are absent, processes often come to a halt, rather than operate effectively under prepared schedules or with trained backups. Record keeping in some areas, such as contract files is very detailed, but in other areas including master lists of current guidance and criteria and consistent utilization of ARMS, is inadequate. Controls over customer requirements and monitoring those requirements through processes to final product delivery are also important vulnerabilities that need to be addressed. Project management plans required by ER 5-7-1, *Project Management*, offer a format for strengthening controls over quality management processes and systems and need to be updated continuously through process delivery.

Pursuing improvements under each of these critical ISO 9000 standards will require much work; however, unless those improvement efforts are established within the comprehensive and coordinated framework of a quality management system, the Corps will not be able to comply with the standards. Establishing process action teams and quality management boards is to be applauded, but the efforts of such groups must be cohesive and focused. Structured and selective training programs tied to objectives clearly set forth in a quality management plan will ensure that such training is effective. A number of districts have prepared strategic plans for quality enhancement, but they fall short of specifying the level of detail or comprehensiveness required for quality systems that would lead to ISO 9000 registration.

Fortunately, USACE field offices appear to have a strong interest in quality improvement through use of quality systems. Some district commanders and their management teams have already demonstrated their commitment to improve quality, and we sense that application of the ISO 9000 standards may present an opportunity for districts to better channel those improvement initiatives. Adopting the ISO 9000 standards could certainly provide an effective foundation for all USACE quality initiatives, including TAQ.

CHAPTER 4

Conclusions and Recommendations

The USACE is the world's largest engineering and design organization and is responsible for executing around $700 million worth of engineering and design work every year. Its product has long been a symbol of engineering expertise. Today, USACE's customers are asking for more. While they still want and need USACE's functional expertise, they are now demanding total quality in USACE products and services. The issues of quality engineering product and the costs of delivering that product are becoming increasingly important as military construction budgets decrease and business with customers outside DoD becomes necessary to sustain the current USACE business base. To continue as the world's foremost engineering and design organization, USACE must deliver the products its customers want, on schedule, within budget, and with excellent service. For USACE to meet its customers' demands for total quality, it must change the way it delivers engineering and design products — it needs to institute quality into the very framework of the organization and processes that deliver its products.

Recognizing the importance of costs, schedules, and quality products, USACE has recently undertaken a number of separate initiatives to improve the quality of the processes it uses to deliver those products. While those initiatives are a step in the right direction, they do not go far enough. What is needed is a structured approach or "blueprint" for integrating all the separate quality initiatives USACE is now undertaking in order to keep its efforts and the resources devoted to those efforts focused. USACE needs to establish a solid quality system foundation first, including sound quality management practices backed by quality documentation, before the maximum benefits of the other programs can be realized.

The ISO 9000 series standards provide a ready recipe for establishing a fundamental quality management system framework that will deliver numerous benefits. Adopting the ISO 9000[1] quality assurance standards offers USACE a systematic approach to implementing bona fide quality management practices by forcing it to comply with the 20 elements of the ISO 9001 quality assurance standard. By adopting the standards, USACE will be emplacing an excellent quality system foundation that is internationally recognized in both the private and public sectors. Appendix C shows how the ISO 9001 standards can be adapted to USACE operations and offers some guidelines that show what USACE field activities will need to do to comply with the standards. This chapter provides our conclusions about using those ISO quality standards and presents our recommendations for how USACE should adopt them.

[1] ISO 9001 is recommended because of the impact that design planning has on the eventual quality of the finished product in terms of its ability to meet the customer's requirements, on time, and within budget.

CONCLUSIONS

Because they work, the ISO 9000 quality standards are rapidly becoming the world's preferred and established criteria for gauging the acceptability of an organization's quality system. Thousands of organizations in Europe, Asia, and the Americas are adopting quality management practices consistent with the ISO standards to improve productivity, customer service and satisfaction, and the organization's competitive posture. While they are not the ultimate world-class quality systems embodied by the MBNQA or the Presidential Award for Quality, the ISO standards offer a significant first step toward achieving higher quality systems of the future. Thus, every indication is that customers will continue to use the ISO-based standards in the United States as the primary method for evaluating the adequacy of a supplier's quality system and a growing number of organizations will use them as models for improving or implementing internal quality systems. The ISO standards are here to stay.

One of the greatest benefits to USACE is that the ISO quality system standards can be adopted with little to no modification to them. They are already well-documented, internationally recognized, and have stood the test of time. Since they were developed according to private-sector guidelines and can be adapted to public-sector operations, USACE does not have to "reinvent the wheel." ISO 9000 standards should serve as the blueprint for ongoing USACE field office quality initiatives.

The ISO 9000 standards can fulfill two roles for USACE. First, they can be used to establish an internal quality management system that will reap significant benefits. A standard quality system framework will help to integrate all other USACE quality initiatives into a coherent program that will improve internal productivity. Second, the standards can be used to improve the costs, timeliness, and quality of the products USACE receives from its A-E contractors and other suppliers if it uses them as a basis for selecting those contractors. The following sections discuss further the implications of using the ISO standards for internal quality system improvement and external quality assurance.

Internal Quality System Improvements

Currently, no external customers demand (or will in the foreseeable future) that USACE comply with any of the ISO quality models. However, USACE field activities can still receive significant benefits by establishing basic quality management practices in their operations. The benefits of an improved internal quality management system and of ISO registration cannot be realized without a reasonable investment of USACE resources. The typical USACE field office will face its biggest hurdle in developing the required ISO-based procedures, documenting those procedures, and properly training everyone in the engineering community in the new quality system and standards. Other organizations about the same size as a typical USACE field office spend around $350,000 (registration is between $20,000 and $40,000) to meet ISO requirements and to

register, depending on how broad the quality system being audited is and how many tries are needed before the field office passes the audit. We expect an equivalent per-site cost for the first several USACE field activities adopting and becoming registered to the standards.

However, USACE need not spend as much for subsequent sites since many of its field activities share the same engineering and design mission, the same regulations, and perform the same major engineering work processes. As activities learn to adopt ISO 9000 standards, create and document the requisite procedures, and become comfortable in their applications, a valuable library of documentation and lessons learned will emerge. As a result, subsequent field offices can then simply modify the generic documentation with a minimal effort instead of having to develop their own procedures and documentation from scratch. HQUSACE can minimize its overall costs by first generating the needed interest and commitment from its leadership at field activities and then developing the needed implementation guidance on steps that must be taken to register, the generic procedures and quality documentation needed to comply, and the required awareness training. Further, the actual cost of registration could be reduced by selecting a single accredited registrar to serve all USACE field offices interested in pursuing ISO registration. That procedure will eliminate the need for each field office to identify, select, and contract with individual registrars.

Successful implementation of an ISO-registered quality management system requires leadership commitment. That commitment is better achieved when the leadership is self-motivated to make the quality system work. While USACE could realize many of the benefits of ISO 9000 simply by self-regulating to the standards (and not exposing its system to outside registration), that approach would require a level of discipline and commitment that many field offices would find difficult to sustain, especially as their leadership changes. Registering to the ISO 9000 quality assurance standards maximizes the opportunity for benefits by ensuring all elements of ISO 9000 quality systems are met, establishing a constancy of purpose, and sustaining a level of commitment from everyone in the organization, including upper management. In that respect, registration to the ISO standards provides field activities with the motivation and incentives that self-regulation does not, and it establishes a consistent quality framework for continual improvement that would be difficult to dismantle even in the face of leadership changes. Additionally, the incremental cost to register the quality management system is minor compared with the costs to comply with all elements of the ISO standards.

We believe the benefits that field offices will receive from registration will outweigh the average implementation cost of around $350,000 per site. The immediately quantifiable benefits from establishing an ISO-compliant quality system will come from a reduction in lost design effort, lower reproduction costs, higher productivity of the in-house staff, and, as a result, a reduction of the field activity's local supervision and review (S&R) rates. The following subsections describe some of the benefits that will accrue to the field offices as a consequence of their adopting the ISO standards and registering.

A Successful Quality System Framework

While ISO standards are not the ultimate criteria – MBNQA or the Presidential Award for Quality are more significant – they establish the fundamental elements of an unequivocal quality management system. Adhering to the basic 20 elements of the ISO 9001 quality assurance standard offers USACE field activities a proven formula for building a foundation for their quality systems – whether they are just beginning their quality improvement efforts or have a long-established tradition of quality management. Since quality improvement efforts at a significant number of organizations fail for the lack of fundamental quality system elements, adhering to the ISO 9000 standards offers field offices the needed foundation upon which to base their other quality initiatives – TAQ, for example.

Operational Consistency and Product Uniformity

The basic principles of the ISO standards require that USACE field activities document all the procedures they currently use to develop engineering and design products and maintain the documented quality throughout the entire design process. External registrars audit the processes to ensure that documented procedures are followed. As a result, procedures will be improved and their applications will be consistent because of the documentation. ISO does not specify how the designs should be done or that they be done particularly well; it merely requires that the designs be well documented and that the organization follow what it has written.

Improved Document Control

One of the ISO standards is dedicated to document control and will be one of the most difficult to adopt successfully. However, when USACE meets the intent of that standard, it will have established an effective means for controlling all of its essential documentation. Effective document control will improve productivity and reduce design effort by eliminating circumstances in which out-of-date or last-revision design documents are inadvertently mistaken for current ones, for example.

Higher Quality Engineering and Design Products

In documenting the design delivery processes, the implementing activity is likely to uncover and correct inefficiencies, which should lead to better procedures. Once the baseline is established, the ISO standards will force the engineering organization to continually improve the processes it uses to deliver its engineering and design products and services. The result is higher quality processes, increases in productivity – waste and rework are minimized – better discipline, and higher quality products because the organization must apply its resources and efforts to doing the right things. The strict documentation of

procedures and records of reviews and approvals makes it easy to focus on problems and ensures that mistakes can be traced to their origins. Programs such as TAQ that are already in place at many USACE field activities offer ideal vehicles for continually improving current processes. Others may want to implement TAQ, select some other TQM program, or choose reengineering exercises to improve current processes.

Improved Employees Motivation

Most employees resist change, and adopting the ISO standards and instituting quality systems at USACE field activities will certainly result in change. However, the experience of other registered engineering and design firms suggests that employees appreciate the structure, documentation, and systematic procedures that the ISO standards demand. The basis of the ISO-compliant quality system is documentation, structure, and consistent application of those procedures. Most employees at field activities would probably prefer to follow established procedures than waste time and effort figuring out how something should be done. For example, something as simple as design drawing naming conventions, document and revision numbering, and even the location of title blocks will be documented and standardized under ISO 9000, and once the standard procedures are developed and implemented, most employees will appreciate their consistent application. An added benefit results from including these same employees in the development and codification of the procedures. Much will be gained from the increase in morale resulting from the most basic aspect of empowerment. In addition, actually creating the documentation gives employees the opportunity to participate in the development of the processes.

Better Customer Service and Competitive Position

Satisfaction is the direct result of meeting or, better yet, exceeding the customer's expectations of service. The ISO standards will require USACE field offices to involve their customers in the design planning and development process and ensure that customer needs are addressed in the design planning phase, during design development, and before designs are finalized and approved. Thus, it follows that customer service and customer satisfaction will improve. The side benefit is that the lines of communication with its customers will be expanded. Higher customer satisfaction brings higher customer loyalty.

Some USACE districts are beginning to compete for work. Some of USACE's customers are starting to shop around for the district or outside engineering firm that will give them the best "deal" on costs, service, and quality. Districts that can demonstrate a quality system that complies with the ISO standards will have an advantage over districts or other engineering firms that do not, and districts that provide excellent service will retain customers that otherwise may have looked elsewhere or for other alternatives for getting work done.

The Corps customers should not be expected to determine the benefits of ISO registration for themselves. USACE must educate them on the significance of ISO quality systems. While TAQ certainly has its place in USACE's total quality efforts, simply saying that you have TAQ provides little tangible proof to customers. ISO registration, on the other hand, does provide that tangible proof that bona fide quality systems are a part of everyday operations and the customer's requirements for quality will likely be met.

Improved Image and Recognition

Registration under the ISO standards demonstrates to existing and potential USACE customers and its peers in the engineering community that it is truly committed to quality management and customer service. No longer could they question USACE's commitment to quality. The ISO registration proves to the rest of the industry and its customers that USACE takes quality seriously. The registration legitimizes its quality initiatives and has the backing of private-sector and internationally recognized authorities. The ISO registration opens doors that might otherwise remain closed. Registration will permit the field activity to advertise its accomplishments in all brochures, letters, and literature and can be used as a marketing tool for informing USACE's existing and potential customers about its accomplishments in quality management and customer service.

Keeps Options Open

The ISO registration phenomenon is growing rapidly throughout the world. Nearly every industrialized country has now adopted the ISO standards as its national quality system standards. In the United States, the ISO standards are gaining increasing acceptance throughout industry and the government. DoD has already established an ISO task force to determine the role that the standards should play in the military establishment. The North American Free Trade Agreement (NAFTA) is considering the use of ISO standards to provide quality assurance across the borders. Where all this is leading is still uncertain and will not be known for another 6 to 12 months or longer. While the U.S. Government, DoD, or USACE's customers are not requiring ISO certification today, we cannot say conclusively that at least some of those customers or potential customers will not require or encourage such certification in the future. If its customers begin to require registration or it finds that registration gives field activities a competitive advantage over those that are not registered, USACE will already be in a position to meet that demand.

Less Effort to Manage at HQUSACE

Where field activities register to ISO, the burden of audits, recommended system improvements, monitoring of results, and system reassessments falls on the independent ISO registrar chosen by the field activities. HQUSACE will

simply need to monitor the status of field activities seeking registration and provide the necessary policy and guidance related to ISO registration.

Motivation Toward a Goal

Most organizations that set out to register finally do so and because they have put time and effort into complying with the registration requirements, their quality system is improved and the benefits cited here are realized. Registration to ISO 9000 will establish a quality system goal that, once undertaken, the field activities will make every effort to meet. Field activities that register successfully are likely to maintain their registration even as top leadership changes. With an established quality management system that is dependent on periodic reassessment audits, new management will be hard pressed to find reasons to discontinue the quality practice.

Quality Assurance of Architect-Engineering Contractors

Another use for the ISO standards is external quality assurance. The objective of such a quality assurance program is to ensure the products that USACE receives from its A-E contractors and suppliers consistently conform to specified requirements. That means getting engineering and design products that meet USACE's and its customer's quality, cost, schedule, and functional requirements. To meet that need, USACE currently requires A-E contractors to submit a quality control plan along with other submittals for each contracted project that demonstrates how the firm will respond to USACE's requirements with respect to quality. USACE field activities review those plans for sufficiency during the A-E selection process. Firms must meet the requirement or they will be eliminated from further consideration. The problem with this method is that after selection and final negotiations, the A-E firm awarded the contract may not live up to the level of quality that they clearly document in their quality plan.

Instead of relying solely on the quality control plans submitted by A-E contractors, USACE can begin considering registration to one of the ISO quality assurance standards (ISO 9001 or ISO 9002) as part of the selection criteria during A-E selection. Firms that are registered to the ISO standard are held to the same strict quality system requirements previously discussed and therefore are better able to meet USACE's quality demands. Registered A-E firms would not have to submit the same detailed quality control plans as unregistered firms since accredited independent auditors would have already verified that the A-E firms have established quality practices in place. Perhaps the quality manual required by ISO along with a project-specific quality plan would be all that is needed. Firms that are not registered should be required to submit quality control plans that address each of the quality system elements contained in ISO 9001 for quality management processes and, in addition, information on how they intend to meet schedule and costs for particular projects. In addition to simplifying the evaluation of its A-E contractors, USACE leadership will be sending a clear message to the engineering and design industry – USACE takes quality seriously.

Promoting the ISO standards as its quality assurance mechanism will further enhance its image as a world-class organization. A statement for promulgation in the *Commerce Business Daily (CBD)* is shown in Figure 4-1.

CBD Announcement

. . . "We are a total quality organization and we prefer to work with contractors who are equally committed to quality management. The selection of the most qualified A-E contractor will be partly based on the contractor's ability to meet the ISO 9000 quality standards. Consideration will be given to firms already registered to ISO 9001 quality assurance standards or to firms whose quality management plans conform to the ISO standards." . . .

Figure 4-1.
Possible CBD Announcement

RECOMMENDATIONS

While a great deal of evidence supports the claim that private industry is experiencing significant cost savings and benefits from adopting and registering to the ISO 9000 quality system standards, we have little actual experience from Federal agencies. We believe that USACE field activities will also realize exceptional quantifiable benefits from putting the ISO quality system elements into action. However, because the USACE engineering and design processes function under government regulations and in a bureaucracy, we recommend a somewhat more cautious approach to adopting the ISO 9000 quality framework. We recommend that USACE begin implementing the following strategy for improving its quality management systems using the ISO 9000 quality system standards.

- *HQUSACE should evaluate the costs and benefits of ISO registration at two to four test sites (field activities) to determine whether ISO registration should be generally encouraged at all USACE field activities.* The actual savings that USACE field offices will generate as a direct result of registering to ISO 9000 standards is still uncertain. Since costs to emplace ISO 9000 standards could exceed $350,000 per site, we recommend that USACE proceed with ISO implementation cautiously. Since some USACE districts have already expressed interest in adopting the ISO standards, we suggest that two to four of those sites be selected to test the concept. The pilot locations will establish a baseline for evaluating the costs and benefits of ISO registration using metrics such as lost design, S&R rates, and customer satisfaction and awareness, for example. HQUSACE should support the registration goal by funding the

development and documentation of the required ISO-qualified processes as well as developing the awareness training needed to educate the employees about ISO. In support of that goal, HQUSACE needs to establish an implementation strategy for the pilot locations. The strategy should typically include a detailed plan of action, criteria used to evaluate success or failure, estimated costs for ISO implementation and registration, an outline of responsibilities, and a plan for expanding the quality initiatives beyond the engineering domain. A strategy should also be developed that will move USACE field activities beyond the minimum quality requirements established by ISO 9000 toward the world-class quality systems embodied by the MBNQA and the Presidential Award for Quality. Successful field activities should promote their success in trade journals, newsletters, and other industry forum to make sure the message is well received in the engineering industry and throughout its customer base.

- *If emplacement of ISO 9000 standards is found to be justified at the test locations, USACE should encourage all field offices to begin seeking registration to the ISO 9001 quality assurance standards.* If the benefits realized by the pilot sites can justify the total costs to implement and maintain registration, HQUSACE should initiate a program to register all of its field activities that want to become registered. HQUSACE should make the field offices aware of the ISO standards, the benefits of quality management systems, and the costs of adopting and registering to the ISO standards. Promotion of the ISO standards by HQUSACE is imperative to the success of the initiative. Since success cannot be mandated from the top, leadership at field activities must be internally motivated to adopt what may be a dramatically new way of doing business. HQUSACE should consider creating recognition and incentive programs to acknowledge those field activities that have become registered.

- *From the procedures, documentation, and awareness training developed for the test sites, HQUSACE should generate documentation templates that can be readily adapted by any USACE field activity wishing to become registered.* Templated procedures will go a long way in simplifying registration for subsequent field activities wishing to do so. As a result, the per-site costs can be significantly reduced. Implementation guidance should also be developed to assist the field activities with a step-by-step approach for becoming registered.

- *The USACE should begin including ISO registration as a weighted criterion in the A-E selection process.* Independent of using the ISO standards to improve internal quality systems, HQUSACE should encourage the use of the standards for external quality assurance. Currently, too few A-E firms are ISO-registered to require ISO registration in the selection process. But at this time, by encouraging ISO registration, USACE will be sending a clear message that quality is something that USACE takes seriously and that in the future only A-E firms that are equally committed to quality will be considered in the selection process. Their registrations to the ISO standards will demonstrate their commitment.

The USACE is the world's largest engineering and design firm with a new challenging mission to deliver the total quality its customers expect. Quality means engineering organizations at USACE field activities must deliver products that meet their customers' functional and technical needs, on schedule, and within a competitive cost. A growing number of USACE customers are no longer captive; they are finding alternative ways to get their work accomplished. If USACE expects to keep its customers and even attract new ones, its field activities must embrace the concepts of total quality and customer service. The quality of its product will be a major factor in determining whether those customers choose to use USACE or get their work done elsewhere. Adopting the ISO 9000 standards is the first step toward ensuring that fundamental quality management practices are well established at USACE field activities and that they become the core of USACE business practices. From that solid quality foundation, other quality initiatives can better succeed and help to move USACE toward the world-class engineering organization that it needs to be.

APPENDIX A

Total Army Quality in the U.S. Army Corps of Engineers

DEPARTMENT OF THE ARMY
U.S. Army Corps of Engineers
WASHINGTON, D.C. 20314-1000

REPLY TO
ATTENTION OF:

CERM-O

22 APR 1993

MEMORANDUM FOR Commanders, USACE Commands

SUBJECT: Total Army Quality in the U. S. Army Corps of Engineers

1. References:

a. AR 5-1, Army Management Philosophy, 12 June 1992.

b. Leadership for Total Army Quality (Encl).

2. Despite this time of uncertainty and turbulence the USACE team has demonstrated that our tradition remains strong. We remain strong because of the ability of our people to rise to meet great challenges, to skillfully address our nation's national security and domestic needs, and to identify opportunities for innovation and initiative.

3. Total Army Quality (TAQ) is a means for us to equip our people with the necessary skills to enhance our effectiveness. A number of organizations have already begun to implement the principles of this leadership and management philosophy. We can learn from their experience as we implement TAQ across the command. I encourage you to adopt the TAQ concept and ask you to determine how best to implement it within your organization.

4. As we embark upon this mutual endeavor, we must keep in mind that TAQ is not a program and that implementation is the responsibility of all leaders and managers. I have asked the Director of Resource Management to provide coordination and liaison during the initial phases of implementation. He has established an electronic network to facilitate sharing ideas and lessons-learned. Information about this network will be distributed separately.

5. You have my fullest support in this effort. I look forward to hearing about your successes.

Arthur E. Williams

ARTHUR E. WILLIAMS
Lieutenant General, USA
Commanding

Encl

APPENDIX B

The ISO Standards

QUALITY SYSTEMS — MODEL FOR QUALITY ASSURANCE IN DESIGN/DEVELOPMENT, PRODUCTION, INSTALLATION, AND SERVICING

0.0 INTRODUCTION

This Standard is one of a series of three Standards dealing with quality systems that can be used for external quality assurance purposes. The alternative quality assurance models, set out in the three Standards listed below, represent three distinct forms of functional or organizational capability suitable for two-party contractual purposes:

— ANSI/ASQC Q91-1987, *Quality Systems — Model for Quality Assurance in Design/Development, Production, Installation, and Servicing.*

For use when conformance to specified requirements is to be assured by the supplier during several stages which may include design/development, production, installation, and servicing.

— ANSI/ASQC Q92-1987, *Quality Systems — Model for Quality Assurance in Production and Installation.*

For use when conformance to specified requirements is to be assured by the supplier during production and installation.

— ANSI/ASQC Q93-1987, *Quality Systems — Model for Quality Assurance in Final Inspection and Test.*

For use when conformance to specified requirements is to be assured by the supplier solely at final inspection and test.

It is emphasized that the quality system requirements specified in this Standard, Standards Q92 and Q93 are complementary (not alternative) to the technical (product/service) specified requirements. These Standards are technically equivalent to the International Standards ISO 9001, 9002, and 9003 respectively.

It is intended that these Standards will normally be adopted in their present form, but on occasions they may need to be tailored for specific contractual situations. Q90 provides guidance on such tailoring as well as selection of the appropriate quality assurance model, namely Q91, Q92, or Q93.

1.0 SCOPE AND FIELD OF APPLICATION

1.1 Scope

This Standard specifies quality system requirements for use where a contract between two parties requires the demonstration of a supplier's capability to design and supply product. The requirements specified in this Standard are aimed primarily at preventing nonconformity at all stages from design to servicing.

1.2 Field of Application

This Standard is applicable in contractual situations when:

a) the contract specifically requires design effort and the product requirements are stated principally in performance terms or they need to be established;

b) confidence in product conformance can be attained by adequate demonstration of certain supplier's capabilities in design, development, production, installation, and servicing.

2.0 REFERENCES

ANSI/ASQC A3, *Quality Systems Terminology.*

ISO 8402-1986, *Quality — Vocabulary.*

ANSI/ASQC Q90-1987 *Quality Management and Quality Assurance Standards — Guidelines for Selection and Use.*

ISO 9000-1987, *Quality Management and Quality Assurance Standards — Guidelines for Selection and Use.*

3.0 DEFINITIONS

For the purposes of this Standard, the definitions given in ANSI/ASQC A3 apply.

NOTE: For the purposes of this Standard, the term "product" is also used to denote "service," as appropriate.

4.0 QUALITY SYSTEM REQUIREMENTS

4.1 Management Responsibility

4.1.1 Quality Policy

The supplier's management shall define and document its policy and objectives for, and commitment to, quality. The supplier shall ensure that this policy is understood, implemented, and maintained at all levels in the organization.

4.1.2 Organization

4.1.2.1 Responsibility and Authority

The responsibility, authority, and the interrelation of all personnel who manage, perform, and verify work affecting

quality shall be defined; particularly for personnel who need the organizational freedom and authority to:

a) initiate action to prevent the occurrence of product nonconformity;
b) identify and record any product quality problems;
c) initiate, recommend, or provide solutions through designated channels;
d) verify the implementation of solutions;
e) control further processing, delivery, or installation of nonconforming product until the deficiency or unsatisfactory condition has been corrected.

4.1.2.2 Verification Resources and Personnel

The supplier shall identify in-house verification requirements, provide adequate resources, and assign trained personnel for verification activities (see 4.18).

Verification activities shall include inspection, test, and monitoring of the design, production, installation, and servicing of the process and/or product; design reviews and audits of the quality system, processes, and/or product shall be carried out by personnel independent of those having direct responsibility for the work being performed.

4.1.2.3 Management Representative

The supplier shall appoint a management representative who, irrespective of other responsibilities, shall have defined authority and responsibility for ensuring that the requirements of this Standard are implemented and maintained.

4.1.3 Management Review

The quality system adopted to satisfy the requirements of this Standard shall be reviewed at appropriate intervals by the supplier's management to ensure its continuing suitability and effectiveness. Records of such reviews shall be maintained (see 4.16).

NOTE: Management reviews normally include assessment of the results of internal quality audits, but are carried out by, or on behalf of, the supplier's management, namely management personnel having direct responsibility for the system (see 4.17).

4.2 Quality System

The supplier shall establish and maintain a documented quality system as a means of ensuring that product conforms to specified requirements. This shall include:

a) the preparation of documented quality system procedures and instructions in accordance with the requirements of this Standard;
b) the effective implementation of the documented quality system procedures and instructions.

NOTE: In meeting specified requirements, timely consideration needs to be given to the following activities:

a) the preparation of quality plans and a quality manual in accordance with the specified requirements;
b) the identification and acquisition of any controls, processes, inspection equipment, fixtures, total production resources, and skills that may be needed to achieve the required quality;
c) the updating, as necessary, of quality control, inspection, and testing techniques, including the development of new instrumentation;
d) the identification of any measurement requirement involving capability that exceeds the known state of the art in sufficient time for the needed capability to be developed;
e) the clarification of standards of acceptability for all features and requirements, including those which contain a subjective element;
f) the compatibility of the design, the production process, installation, inspection and test procedures, and the applicable documentation;
g) the identification and preparation of quality records (see 4.16).

4.3 Contract Review

The supplier shall establish and maintain procedures for contract review and for the coordination of these activities.

Each contract shall be reviewed by the supplier to ensure that:

a) the requirements are adequately defined and documented;
b) any requirements differing from those in the tender are resolved;
c) the supplier has the capability to meet contractual requirements.

Records of such contract reviews shall be maintained (see 4.16).

NOTE: The contract review activities, interfaces, and communication within the supplier's organization should be coordinated with the purchaser's organization, as appropriate.

4.4 Design Control

4.4.1 General

The supplier shall establish and maintain procedures to control and verify the design of the product in order to ensure that the specified requirements are met.

4.4.2 Design and Development Planning

The supplier shall draw up plans that identify the responsibility for each design and development activity. The plans shall describe or reference these activities and shall be updated as the design evolves.

4.4.2.1 Activity Assignment

The design and verification activities shall be planned and assigned to qualified staff equipped with adequate resources.

4.4.2.2 Organizational and Technical Interfaces

Organizational and technical interfaces between different groups shall be identified and the necessary information documented, transmitted, and regularly reviewed.

4.4.3 Design Input

Design input requirements relating to the product shall be identified, documented, and their selection reviewed by the supplier for adequacy.

Incomplete, ambiguous, or conflicting requirements shall be resolved with those responsible for drawing up these requirements.

4.4.4 Design Output

Design output shall be documented and expressed in terms of requirements, calculations, and analyses.

Design output shall:

a) meet the design input requirements;
b) contain or reference acceptance criteria;
c) conform to appropriate regulatory requirements whether or not these have been stated in the input information;
d) identify those characteristics of the design that are crucial to the safe and proper functioning of the product.

4.4.5 Design Verification

The supplier shall plan, establish, document, and assign to competent personnel functions for verifying the design.

Design verification shall establish that design output meets the design input requirement (see 4.4.4) by means of design control measures such as:

a) holding and recording design reviews (see 4.16);
b) undertaking qualification tests and demonstrations;
c) carrying out alternative calculations;
d) comparing the new design with a similar proven design, if available.

4.4.6 Design Changes

The supplier shall establish and maintain procedures for the identification, documentation, and appropriate review and approval of all changes and modifications.

4.5 Document Control

4.5.1 Document Approval and Issue

The supplier shall establish and maintain procedures to control all documents and data that relate to the requirements of this Standard. These documents shall be reviewed and approved for adequacy by authorized personnel prior to issue. This control shall ensure that:

a) the pertinent issues of appropriate documents are available at all locations where operations essential to the effective functioning of the quality system are performed;
b) obsolete documents are promptly removed from all points of issue or use.

4.5.2 Document Changes/Modifications

Changes to documents shall be reviewed and approved by the same functions/organizations that performed the original review and approval unless specifically designated otherwise. The designated organizations shall have access to pertinent background information upon which to base their review and approval.

Where practicable, the nature of the change shall be identified in the document or the appropriate attachments.

A master list or equivalent document control procedure shall be established to identify the current revision of documents in order to preclude the use of non-applicable documents.

Documents shall be re-issued after a practical number of changes have been made.

4.6 Purchasing

4.6.1 General

The supplier shall ensure that purchased product conforms to specified requirements.

4.6.2 Assessment of Sub-Contractors

The supplier shall select sub-contractors on the basis of their ability to meet sub-contract requirements, including quality requirements. The supplier shall establish and maintain records of acceptable sub-contractors (see 4.16).

The selection of sub-contractors, and the type and extent of control exercised by the supplier, shall be dependent upon

the type of product and, where appropriate, on records of subcontractors' previously demonstrated capability and performance.

The supplier shall ensure that quality system controls are effective.

4.6.3 Purchasing Data

Purchasing documents shall contain data clearly describing the product ordered, including, where applicable:

a) the type, class, style, grade, or other precise identification;
b) the title or other positive identification, and applicable issue of specifications, drawings, process requirements, inspection instructions, and other relevant technical data, including requirements for approval or qualification of product, procedures, process equipment and personnel;
c) the title, number, and issue of the quality system Standard to be applied to the product.

The supplier shall review and approve purchasing documents for adequacy of specified requirements prior to release.

4.6.4 Verification of Purchased Product

Where specified in the contract, the purchaser or the purchaser's representative shall be afforded the right to verify at source or upon receipt that purchased product conforms to specified requirements. Verification by the purchaser shall not absolve the supplier of the responsibility to provide acceptable product nor shall it preclude subsequent rejection.

When the purchaser or the purchaser's representative elects to carry out verification at the sub-contractor's plant, such verification shall not be used by the supplier as evidence of effective control of quality by the sub-contractor.

4.7 Purchaser Supplied Product

The supplier shall establish and maintain procedures for verification, storage, and maintenance of purchaser supplied product provided for incorporation into the supplies. Any such product that is lost, damaged, or is otherwise unsuitable for use shall be recorded and reported to the purchaser (see 4.16).

NOTE: Verification by the supplier does not absolve the purchaser of the responsibility to provide acceptable product.

4.8 Product Identification and Traceability

Where appropriate, the supplier shall establish and maintain procedures for identifying the product from applicable drawings, specifications, or other documents, during all stages of production, delivery, and installation.
Where, and to the extent that, traceability is a specified requirement, individual product or batches shall have a unique identification. This identification shall be recorded (see 4.16).

4.9 Process Control

4.9.1 General

The supplier shall identify and plan the production and, where applicable, installation processes which directly affect quality and shall ensure that these processes are carried out under controlled conditions. Controlled conditions shall include the following:

a) documented work instructions defining the manner of production and installation, where the absence of such instructions would adversely affect quality, use of suitable production and installation equipment, suitable working environment, compliance with reference standards/codes, and quality plans;
b) monitoring and control of suitable process and product characteristics during production and installation;
c) the approval of processes and equipment, as appropriate;
d) criteria for workmanship which shall be stipulated, to the greatest practicable extent, in written standards or by means of representative samples.

4.9.2 Special Processes

These are processes, the results of which cannot be fully verified by subsequent inspection and testing of the product and where, for example, processing deficiencies may become apparent only after the product is in use. Accordingly, continuous monitoring and/or compliance with documented procedures is required to ensure that the specified requirements are met. These processes shall be qualified and shall also comply with the requirements of 4.9.1.

Records shall be maintained for qualified processes, equipment, and personnel, as appropriate.

4.10 Inspection and Testing

4.10.1 Receiving Inspection and Testing

4.10.1.1 The supplier shall ensure that incoming product is not used or processed (except in the circumstances described in 4.10.1.2) until it has been inspected or otherwise verified as conforming to specified requirements. Verification shall be in accordance with the quality plan or documented procedures.

4.10.1.2 Where incoming product is released for urgent production purposes, it shall be positively identified and recorded

(see 4.16) in order to permit immediate recall and replacement in the event of nonconformance to specified requirements.

NOTE: In determining the amount and nature of receiving inspection, consideration should be given to the control exercised at source and documented evidence of quality conformance provided.

4.10.2 In-Process Inspection and Testing

The supplier shall:

a) inspect, test, and identify product as required by the quality plan or documented procedures;
b) establish product conformance to specified requirements by use of process monitoring and control methods;
c) hold product until the required inspection and tests have been completed or necessary reports have been received and verified except when product is released under positive recall procedures (see 4.10.1). Release under positive recall procedures shall not preclude the activities outlined in 4.10.2 a);
d) identify nonconforming product.

4.10.3 Final Inspection and Testing

The quality plan or documented procedures for final inspection and testing shall require that all specified inspection and tests, including those specified either on receipt of product or in-process, have been carried out and that the data meets specified requirements.

The supplier shall carry out all final inspection and testing in accordance with the quality plan or documented procedures to complete the evidence of conformance of the finished product to the specified requirements.

No product shall be dispatched until all the activities specified in the quality plan or documented procedures have been satisfactorily completed and the associated data and documentation is available and authorized.

4.10.4 Inspection and Test Records

The supplier shall establish and maintain records which give evidence that the product has passed inspection and/or test with defined acceptance criteria (see 4.16).

4.11 Inspection, Measuring, and Test Equipment

The supplier shall control, calibrate, and maintain inspection, measuring, and test equipment, whether owned by the supplier, on loan, or provided by the purchaser, to demonstrate the conformance of product to the specified requirements. Equipment shall be used in a manner which ensures that measurement uncertainty is known and is consistent with the required measurement capability.

The supplier shall:

a) identify the measurements to be made, the accuracy required, and select the appropriate inspection, measuring, and test equipment;
b) identify, calibrate, and adjust all inspection, measuring and test equipment, and devices that can affect product quality at prescribed intervals, or prior to use, against certified equipment having a known valid relationship to nationally recognized standards — where no such standards exist, the basis used for calibration shall be documented;
c) establish, document, and maintain calibration procedures, including details of equipment type, identification number, location, frequency of checks, check method, acceptance criteria, and the action to be taken when results are unsatisfactory;
d) ensure that the inspection, measuring, and test equipment is capable of the accuracy and precision necessary;
e) identify inspection, measuring, and test equipment with a suitable indicator or approved identification record to show the calibration status;
f) maintain calibration records for inspection, measuring, and test equipment (see 4.16);
g) assess and document the validity of previous inspection and test results when inspection, measuring, and test equipment is found to be out of calibration;
h) ensure that the environmental conditions are suitable for the calibrations, inspections, measurements, and tests being carried out;
i) ensure that the handling, preservation, and storage of inspection, measuring, and test equipment is such that the accuracy and fitness for use is maintained;
j) safeguard inspection, measuring, and test facilities, including both test hardware and test software, from adjustments which would invalidate the calibration setting.

Where test hardware (e.g., jigs, fixtures, templates, patterns) or test software is used as suitable forms of inspection, they shall be checked to prove that they are capable of verifying the acceptability of product prior to release for use during production and installation and shall be rechecked at prescribed intervals. The supplier shall establish the extent and frequency of such checks and shall maintain records as evidence of control (see 4.16). Measurement design data shall be made available, when required by the purchaser or his representative, for verification that it is functionally adequate.

4.12 Inspection and Test Status

The inspection and test status of product shall be identified by using markings, authorized stamps, tags, labels, routing cards, inspection records, test software, physical location, or other suitable means, which indicate the conformance or nonconformance of product with regard to inspection and tests performed. The identification of inspection and test status shall be maintained, as necessary, throughout production and installation of the product to ensure that only product that has passed the required inspections and tests is dispatched, used, or installed.

Records shall identify the inspection authority responsible for the release of conforming product (see 4.16).

4.13 Control of Nonconforming Product

The supplier shall establish and maintain procedures to ensure that product that does not conform to specified requirements is prevented from inadvertent use or installation. Control shall provide for identification, documentation, evaluation, segregation when practical, disposition of nonconforming product, and for notification to the functions concerned.

4.13.1 Nonconformity Review and Disposition

The responsibility for review and authority for the disposition of nonconforming product shall be defined.

Nonconforming product shall be reviewed in accordance with documented procedures. It may be:

a) reworked to meet the specified requirements, or
b) accepted with or without repair by concession, or
c) re-graded for alternative applications, or
d) rejected or scrapped.

Where required by the contract, the proposed use or repair of product (see 4.13.1 b) which does not conform to specified requirements shall be reported for concession to the purchaser or the purchaser's representative. The description of nonconformity that has been accepted, and of repairs, shall be recorded to denote the actual condition (see 4.16).

Repaired and reworked product shall be re-inspected in accordance with documented procedures.

4.14 Corrective Action

The supplier shall establish, document, and maintain procedures for:

a) investigating the cause of nonconforming product and the corrective action needed to prevent recurrence;
b) analyzing all processes, work operations, concessions, quality records, service reports, and customer complaints to detect and eliminate potential causes of nonconforming product;
c) initiating preventative actions to deal with problems to a level corresponding to the risks encountered;
d) applying controls to ensure that corrective actions are taken and that they are effective;
e) implementing and recording changes in procedures resulting from corrective action.

4.15 Handling, Storage, Packaging, and Delivery

4.15.1 General

The supplier shall establish, document, and maintain procedures for handling, storage, packaging, and delivery of product.

4.15.2 Handling

The supplier shall provide methods and means of handling that prevent damage or deterioration.

4.15.3 Storage

The supplier shall provide secure storage areas or stock rooms to prevent damage or deterioration of product, pending use, or delivery. Appropriate methods for authorizing receipt and the dispatch to and from such areas shall be stipulated. In order to detect deterioration, the condition of product in stock shall be assessed at appropriate intervals.

4.15.4 Packaging

The supplier shall control packing, preservation, and marking processes (including materials used) to the extent necessary to ensure conformance to specified requirements and shall identify, preserve, and segregate all product from the time of receipt until the supplier's responsibility ceases.

4.15.5 Delivery

The supplier shall arrange for the protection of the quality of product after final inspection and test. Where contractually specified, this protection shall be extended to include delivery to destination.

4.16 Quality Records

The supplier shall establish and maintain procedures for identification, collection, indexing, filing, storage, maintenance, and disposition of quality records.

Quality records shall be maintained to demonstrate achievement of the required quality and the effective operation of

the quality system. Pertinent sub-contractor quality records shall be an element of these data.

All quality records shall be legible and identifiable to the product involved. Quality records shall be stored and maintained in such a way that they are readily retrievable in facilities that provide a suitable environment to minimize deterioration or damage and to prevent loss. Retention times of quality records shall be established and recorded. Where agreed contractually, quality records shall be made available for evaluation by the purchaser or the purchaser's representative for an agreed period.

4.17 Internal Quality Audits

The supplier shall carry out a comprehensive system of planned and documented internal quality audits to verify whether quality activities comply with planned arrangements and to determine the effectiveness of the quality system.

Audits shall be scheduled on the basis of the status and importance of the activity.

The audits and follow-up actions shall be carried out in accordance with documented procedures.

The results of the audits shall be documented and brought to the attention of the personnel having responsibility in the area audited. The management personnel responsible for the area shall take timely corrective action on the deficiencies found by the audit (see 4.1.3).

4.18 Training

The supplier shall establish and maintain procedures for identifying the training needs and provide for the training of all personnel performing activities affecting quality. Personnel performing specific assigned tasks shall be qualified on the basis of appropriate education, training, and/or experience, as required. Appropriate records of training shall be maintained (see 4.16).

4.19 Servicing

Where servicing is specified in the contract, the supplier shall establish and maintain procedures for performing and verifying that servicing meets the specified requirements.

4.20 Statistical Techniques

Where appropriate, the supplier shall establish procedures for identifying adequate statistical techniques required for verifying the acceptability of process capability and product characteristics.

APPENDIX C

Guidelines for ISO 9000 Quality Standards in USACE

Guidelines for ISO 9000 Quality Standards in USACE

The ISO 9000 quality assurance standards were intentionally designed to be unrestrictive. They set broad guidelines for what the basic elements of a quality management system need to be, but they give organizations a great deal of flexibility in how they carry out their quality processes. They do not mandate how activities should be done. The following sections translate each of the 20 ISO 9001 quality assurance standards as they would apply to a typical U.S. Army Corps of Engineers (USACE) field activity. (The numerals in parentheses after each major heading refer to the appropriate section of the ISO 9001 standards as given in Appendix B.) Following the brief description, a set of guidelines shows what USACE field activities need to address to meet the intention of each standard.

Management Responsibility (4.1)

Description

Requires the USACE engineering organization to establish, define, and document its quality policy and objectives and demonstrate its commitment to quality engineering processes and products. Management must ensure that those policies and objectives are understood, implemented, and maintained at all levels of the organization by all personnel directly affecting its quality engineering and design products.

Ultimately, a single person within the engineering organization needs to be vested with the overall responsibility for the organization's quality efforts and ISO 9000 compliance. The overall objective of that function is to make sure engineering products meet the customer requirements for technical sufficiency, costs, and schedule.

Guidelines for Conformity

- ✓ Within the engineering organization, have quality and quality management policies, goals, and objectives been defined and are they well-documented?
- ✓ Are procedures in place to ensure they are effectively communicated and understood by everyone at the district?

- ✓ Has management's commitment to those policies and objectives been defined?

- ✓ Have those policies been communicated to customers and suppliers?

- ✓ Has a distinct group or single person within the engineering organization been charged with overall responsibility for the quality initiative and for ensuring that all ISO 9000 requirements are implemented and maintained? And, is that appointment recorded in the quality manual?

- ✓ Does the management representative have sufficient authority to develop, monitor, and change elements of the quality system?

- ✓ Is the quality system periodically reviewed to ensure its continuing suitability and effectiveness, and are records of those reviews maintained?

- ✓ Are all district personnel adequately trained in the district's quality management program and Total Army Quality (TAQ)?

- ✓ Has the engineering organization defined the responsibilities and authorities of persons involved in design review and internal quality audits as well as persons involved in the identification and recording of any quality problems?

QUALITY SYSTEM (4.2)

Description

Requires the engineering organization to implement and to document an effective quality system that ensures engineering and design (E&D) activities conform to management's requirements for quality. The quality system, which must be well-documented and assure the engineering organization's product and service meet customer requirements, consists of

- a quality manual that addresses all levels of ISO 9000 series standards;

- documented procedures, work instructions, test procedures, and review procedures supporting the specifications contained in the quality manual for all E&D activities; and

- preparation of a quality plan for all new projects that documents customer requirements and shows how those requirements will be met.

The quality system manual must include

- the district engineer's (or designee) signature,

- the district's name and location,
- the district's quality policy,
- current organizational charts,
- designated quality responsibilities,
- accepted management review system,
- approved methods for revising and updating the manual, and
- complete coverage of all quality system elements.

Guidelines for Conformity

✓ Does the engineering organization have a quality manual that fully documents its quality management system, and is that manual in a form that is readily accessible and understood by all employees?

✓ Does the quality manual's stated quality system cover

- preparation of project quality control plans;
- identification and acquisition of controls, processes, inspection and testing equipment, design resources, and skills needed to achieve the required quality;
- identification of any measurement requirement involving capability that exceeds the known state of the art;
- clarification of standards for acceptability of engineering and design products;
- compatibility of the design, design processes, and review and approval procedures; and
- identification and maintenance of quality records?

✓ Has the engineering organization established and documented procedures for preparing quality and quality control plans in accordance with the district's specific customer requirements?

✓ Has the engineering organization established and documented procedures for updating, as necessary, quality control and design review techniques?

- ✓ Has the engineering organization established and documented procedures for verifying compatibility of the design products to its intended initial requirements — in other words, ensuring the customer gets what it wants?

- ✓ Are adequate procedures in place to ensure compliance with the other established quality system, for example, TAQ and the Automated Review Management System (ARMS)?

- ✓ Does the TAQ initiative, as it is being implemented at the district, comply with every element of the ISO 9000 standards?

CONTRACT REVIEW (CUSTOMER REQUIREMENTS REVIEW) (4.3)

Description

For all memorandums of agreement (MOAs), memorandums of understanding (MOUs), and customer contracts, the engineering organization is required to establish a contract review system that

- ensures that all the customers' requirements are adequately defined, documented, and effectively communicated to the engineering organization;

- effectively resolves differences with customers' requirements when they arise;

- ensures that it is capable of meeting the customers' requirements before entering into an agreement for E&D activities; and

- keeps records of all above-related transactions (see records management at 4.16).

Guidelines for Conformity

- ✓ Has the engineering organization established, written, and reviewed its procedures to ensure that all customer requirements are adequately defined and documented (e.g., PBs, PDBs, and DD 1391s)?

- ✓ Has the engineering organization established and written procedures for resolving conflicts with its customers and contractors?

- ✓ Has the engineering organization established and written procedures to ensure its contractors or in-house staff has the capability of meeting the customers' stated requirements?

✓ Are records of all reviews maintained, and are persons conducting those reviews identified?

DESIGN CONTROL (PLANNING) (4.4)

Description

Requires that the engineering organization establish and maintain procedures to control and verify that E&D products meet the requirements specified by the customers, internal policy, and Army regulation. This requires the design planning system to

- establish a framework for initial design planning activities (e.g., project management plan);
- show how designs are initiated, and updated;
- effectively plan who will execute the design (in house or A-E contractor);
- identify technical and informational interfaces between various engineering activities (e.g., determining who is in charge of what);
- establish responsibilities and procedures for identifying, documenting, verifying, and resolving ambiguous or conflicting design requirements;
- establish procedures for ensuring completed designs conform to safety, functional, regulatory, standard designs, and requirements from architectural and engineering instructions;
- assign design review and approval responsibilities;
- establish procedures for identifying, documenting, and periodically reviewing all design changes and modifications;
- establish a link between customer requirements, costs, and the E&D services provided; and
- establish biddability, constructability, and operability review procedures.

Guidelines for Conformity

✓ Are plans developed that identify the responsibility of each distinct activity involved in the project?

✓ Are the project management plans updated as the project evolves?

- ✓ Is the project schedule adequately developed, and are the various project activities assigned to qualified personnel equipped with adequate resources to effectively complete it?
- ✓ Are organization and technical interfaces between different groups identified, documented, and reviewed regularly?
- ✓ Are the cognizant engineering organization's personnel notified of changes as the project evolves?
- ✓ Are customer requirements defined and incorporated during the design development process? Are adequate control mechanisms in place to ensure that they are met?
- ✓ Are procedures in place for resolving incomplete, ambiguous, or conflicting requirements with those responsible for meeting the requirement?
- ✓ Are procedures established for capturing lessons learned, and are they documented and freely distributed to others within the engineering organization?
- ✓ Are persons other than those on the project team responsible for the review and verification of the designs?
- ✓ Are the results of projects recorded and properly filed for future reference (for developing other project management plans)?
- ✓ Are the project management plans checked to ensure they do not conflict with the customers' initial requirements?
- ✓ Are procedures adequate for identifying, documenting, reviewing, and approving all potential changes and modifications to the projects?
- ✓ Are procedures in place for meeting biddability, constructability, and operability requirements?
- ✓ Are USACE systems such as Automated Management and Progress Reporting System and Corps of Engineers Management Information System used effectively?

DOCUMENT CONTROL (4.5)

Description

Requires the engineering organization to establish and maintain an effective document control system that includes procedures for creating, controlling, reviewing, approving, and publishing

- all Army and USACE regulations, pamphlets, circulars, and technical notes;
- the organization's ISO quality manual;
- engineering organization standing operating procedures (SOPs);
- design criteria;
- standard designs;
- ISO-related quality documentation; and
- in-process and completed designs (and related documentation).

The document control system must also establish and maintain procedures for changes and modifications to all related documentation including, how changes are identified on the documents, how revisions are made and identified, and how many revisions are allowed before a document or design must be reissued.

Guidelines for Conformity

- ✓ Are mechanisms in place for controlling the issue and review of all pertinent plans and designs, SOPs, regulations, architectural and engineering instructions (AEIs), design criteria, design standards, ISO-related quality plans, and other documents?
- ✓ Are effective procedures in place for ensuring the identification, documentation, and appropriate review and approval of all design changes and modifications?
- ✓ Are design changes reviewed and approved by the same activities that perform the original review?
- ✓ Before being entered into the system, are all documents checked for appropriate levels of review and approvals?
- ✓ Does a master list of all essential documentation exist to ensure that the most up-to-date documents are in place where they are needed and to ensure that outdated or nonapplicable documents are never used?
- ✓ Is that master list kept current?
- ✓ Do the design reviewers and approvers have access to the relevant documentation and design information in order to effectively perform their functions? (For example, is ARMS used?)

- ✓ Is there a policy for reissuing documents after a certain number of revisions/changes?
- ✓ Are all outdated or obsolete documents removed from the system as well as at points of use?
- ✓ Does a control mechanism for temporary changes or updates exist?

PURCHASING (4.6)

Description

Requires the engineering organization to ensure that all purchased supplies, materials, and, especially, architect-engineering (A-E) services conform to pre-established requirements. To do so, all A-E contractors must be selected on their ability to meet contract (customer) requirements. Also, USACE must establish and maintain records of successful and unsuccessful A-E contractors (e.g., utilize the ACASS). In addition, customers must be able to verify that their requirements can be met by those services contracted to outside A-E firms.

Guidelines for Conformity

- ✓ Do specifications exist for all goods and services (including A-E services) purchased or contracted by the district?
- ✓ Is there a system in place to ensure that all purchased goods and services conform to those specifications?
- ✓ Are A-E contractors selected on the basis of their ability to meet those stated requirements, including any additional quality requirements established by the ISO standards?
- ✓ Do you currently evaluate the quality system of your A-E contractors or suppliers, and is the quality system evaluated based on past experience, evaluation or previous work, on site visits, and/or their registration under the ISO or similar standards?
- ✓ Is a list of qualified A-E contractors kept and maintained, and are those records examined during A-E selection and price negotiations?
- ✓ Are contracts, purchase orders, and delivery orders always reviewed to ensure they contain the necessary requirements?
- ✓ Are A-E contractors ISO-registered (not mandatory)?

- ✓ Is there a mechanism in place to ensure that USACE's customers can verify that their requirements are met by the A-E contractor?

PURCHASER (CUSTOMER)-SUPPLIED PRODUCT (4.7)

Description

Requires the engineering organization to establish control procedures, including recordkeeping, relating to verification, storage, and maintenance of any materials or products supplied by the customers that are used for developing its engineering and design products.

Guidelines for Conformity

- ✓ Are customers' as-built drawings, installation plans, procedure and operating manuals, and/or preliminary design documents effectively controlled while they are being used and, if requested, are they returned to the customers when the project is complete?

- ✓ Does the engineering organization keep records of user-generated request for proposals (RFP) packages so they can be used again if similar work from the same customer is necessary?

PRODUCT IDENTIFICATION AND TRACEABILITY (4.8)

Description

Requires the engineering organization to establish a system to ensure that engineering and design products are uniquely identified and traceable through all stages of the design development process. If errors in the end product are discovered, the designs must be identified adequately enough at various stages to perform an effective audit of the causes of the problems.

Guidelines for Conformity

- ✓ Are all designs and products associated with those designs adequately and uniquely identified?

- ✓ Is a system in place to ensure those products and related support documentation are traceable?

PROCESS CONTROL (4.9)

Description

Requires the engineering organization to identify and plan the E&D development processes/activities that directly affect the quality of the finished product. In addition, those processes/activities must be carried out in controlled conditions that include

- documenting work instructions that define methods of E&D development; use of suitable equipment; suitable work environments; compliance with applicable codes, regulations, standards, and AEI; and quality plans;
- monitoring and controlling, during design development, suitable processes; applicable laws, regulations, codes, design criteria, and standards; and final design characteristics;
- developing criteria for acceptable levels of workmanship;
- identifying appropriate points during design development for viewing and verifying quality elements and approving continuation in the process.

Documented work instructions should include

- methods of work accomplishment,
- tools needed to perform the tasks,
- sequences of activities,
- monitoring requirements,
- necessary inspection and test requirements,
- standard designs used when and where appropriate, and
- sampling requirements, where appropriate

Guidelines for Conformity

✓ Have adequate procedures and work instructions been established on how to perform all activities associated with design development? For example, critical path activity networks or process/activity modeling would be appropriate means for establishing and documenting all such procedures.

- ✓ Is a critical path network of design activities established, and are those critical activities monitored during the design development process?
- ✓ Do standards for what constitutes acceptable performance exist in relation to performance of design activities?
- ✓ Do USACE personnel know what variables in the design process are important to achieve excellent quality?
- ✓ Are detailed process instructions and procedures established and well-documented, and are they easily understood by those that must use them?

INSPECTION AND TESTING (4.10)

Description

Requires the engineering organization to establish and document systems and procedures for effectively inspecting and testing all incoming products from outside contractors and vendors, all in-process E&D activity, and all final E&D products in preparation for delivery to the customers.

Guidelines for Conformity

- ✓ Is there a system in place to ensure the quality of design work contracted to outside A-E firms and other purchased services?
- ✓ Are inspection and review procedures performed in accordance with the quality plan and other documented procedures?
- ✓ Are nonconforming plans and designs identified, and does the system provide procedures for rejecting unacceptable work?
- ✓ Are procedures in place for reviewing and approving in-process designs, and do those procedures handle the rejection of in-process work?
- ✓ Are all designs released only after a final review confirms that release of the designs and other products is acceptable?
- ✓ Are records maintained showing that designs have passed final reviews, what the final review criteria were, and who authorized their release?

INSPECTION, MEASURING, AND TEST EQUIPMENT (4.11)

Description

Requires the engineering organization to establish and document procedures and systems for ensuring the accuracy and precision of all measuring and testing equipment used for ensuring designs conform to pre-established requirements during the design development process.

Guidelines for Conformity

- ✓ Are engineering test equipment (e.g., electronic survey, soils analysis, survey boat equipment, and nuclear densometers) properly controlled and periodically calibrated?
- ✓ Are engineering computer models periodically reviewed and updated as the model assumptions, boundaries, and analytic data change?
- ✓ Are records of calibrations, the results, accuracy and precision, and the status of the equipment kept and maintained?

INSPECTION AND TEST STATUS (4.12)

Description

Requires the engineering organization to establish and document systems and procedures for ensuring that E&D products are suitably identified according to their last review and inspection status throughout the design development process. In addition, the inspection authority responsible for releasing finished designs must be recorded.

Guidelines for Conformity

- ✓ Are conforming and nonconforming design work so marked to indicate their current status, and do other design and engineering personnel have access to and know what that status is of in-process work?
- ✓ Do those personnel who utilize contracted work know what its quality is or its level of acceptability?
- ✓ Do personnel know who is able to release conforming work or reject unacceptable work?

- ✓ Is a system in place for releasing acceptable products?
- ✓ Are adequate records kept to indicate the status and inspection authority responsible for releasing finished designs?

CONTROL OF NONCONFORMING PRODUCT (4.13)

Description

Requires the engineering organization to put systems and procedures in place for identifying and controlling all design breakage and/or design rejections so that design products with identified errors never reach the customer. Procedures must be documented and maintained.

Guidelines for Conformity

- ✓ Does the engineering organization identify and segregate unacceptable design work and ensure unacceptable work is never released to its customers?
- ✓ Are adequate records kept indicating the disposition of unacceptable work?
- ✓ Is a procedure emplaced or a special area within the engineering activity designated for handling unacceptable work?
- ✓ Is a procedure in place for reworking unacceptable work and making it comply with the appropriate standards and/or the customer's requirements?
- ✓ Is a procedure in place for notifying customers of unacceptable work and how that work will be disposed or reworked to conformance?
- ✓ Are reworked designs reviewed for conformance to criteria and customer requirements?

CORRECTIVE ACTION (4.14)

Description

Requires the engineering organization to establish procedures to document and keep records of design errors to

- ◆ investigate causes of inadequate design work and implement corrective actions that will prevent recurrences [for example, use of the Engineering Improvement Recommendation System (EIRS)];

- research relevant quality records, customer complaints, design criteria, SOPs, standard designs, etc., to detect and eliminate potential causes of unacceptable design products;
- verify that corrective actions have been initiated and evaluate their effects on future products; and
- ensure that the necessary procedural changes have been implemented and recorded as a result of corrective actions.

Guidelines for Conformity

- ✓ When work is found to be unacceptable, is the nature and cause of the deficiency identified?
- ✓ Are corrective actions taken to preclude recurrences of common problems?
- ✓ Are procedures available for following up on corrective actions taken?
- ✓ Does the engineering organization verify that corrective actions taken are effective by analyzing risk versus reward or return on investment?
- ✓ Are systems and procedures ever changed as the result of such corrective actions?
- ✓ Is a system available to detect and prevent problem areas?
- ✓ Has the engineering activity prepared a form designated for corrective actions, and are those forms logged and maintained?

HANDLING, STORAGE, PACKAGING, AND DELIVERY (4.15)

Description

Requires the engineering organization to establish and document procedures to properly handle, store, retrieve, and package E&D project materials in house, and deliver finished products to its customers. Elements of that system should include

- secured storage (whether physical storage or in electronic format) to protect in-process designs from theft, deterioration, misuse, or unauthorized revision and
- use of reproduction systems to ensure that customers get the quantity of designs needed and in an acceptable condition.

Guidelines for Conformity

- ✓ Does the engineering organization maintain procedures for the effective handling, storage, packaging, distribution, and delivery of in-process and final plans and designs?
- ✓ Does USACE ensure effective means of handling (for example, computer-aided design development file transfers) its product to minimize risk of damage or deterioration?
- ✓ Are the correct number of copies of plans and specifications prepared to minimize waste but satisfy needs?
- ✓ Are storage locations secure to prevent damage, deterioration, or theft?
- ✓ Can stored plans and designs be located and retrieved easily?
- ✓ Are procedures in place for effectively packaging and delivering finished designs to the customer?
- ✓ Are stored designs periodically inspected to determine obsolescence?

Quality Records (4.16)

Description

Requires the engineering organization to establish and document procedures for creating, keeping, maintaining, retaining, distributing, using, and disposing of all records that affect the product's quality (for example, a records management system). The procedures should specify persons responsible for the records management system, types of records to be maintained, system security, retrieval procedures, retention intervals, means of disposal, and a system for making quality records available to customers and auditors. Quality records should at a minimum consist of

- ◆ the quality manual and any other ISO materials,
- ◆ management review records,
- ◆ project management plans,
- ◆ project-specific quality control plans,
- ◆ contract review records,
- ◆ design review records,

- process control records,
- internal quality system audits,
- measuring and test equipment calibration records,
- personnel training records,
- corrective actions records, and
- records of final designs and any other E&D related products.

Guidelines for Conformity

- ✓ Is a system in place for the identifying, collecting, indexing, filing, storing, maintaining, and disposing of quality records?
- ✓ Are all records legible, properly identified, and marked?
- ✓ Are records easily archived and retrievable?
- ✓ Are all records stored in such a way to preclude damage and/or deterioration over time?
- ✓ Are there policies for retention and disposal?
- ✓ Where agreed contractually, are records accessible by USACE customers and external auditors?

Internal Quality Audits (4.17)

Description

Requires the engineering organization to establish a comprehensive and systematic approach to quality system audits. That system must be planned and documented. The audits must be carried out by properly trained and authorized personnel whose regular responsibilities are outside of the area being audited. They must be effectively scheduled, and records of the findings and follow-up actions must be maintained. The procedures for quality audits must make sure that personnel responsible for that area are notified of the deficiencies so that they can take timely corrective action.

Guidelines for Conformity

- ✓ Are independent quality audits conducted within each division, branch, or section of the engineering organization to verify whether quality activities comply with established procedures, and does a schedule of those audits exist?
- ✓ Are internal audits conducted in accordance with the established procedures?
- ✓ Are audits performed by personnel outside of the functional activity being audited?
- ✓ Does the audit body communicate the results of those audits back to the cognizant division, branch, and section managers?
- ✓ Are corrective actions taken as the result of the audits, and are those changes effective?
- ✓ Have the internal auditors been adequately trained to perform that function — preferably through ISO 9000 auditor training programs?
- ✓ Has the engineering organization generated an internal audit checklist that recognizes its unique design development process?
- ✓ Are quality audit records adequately maintained, and are those records kept at least until the next audit is performed? Are audit results used as a basis for future audits?

TRAINING (4.18)

Description

Requires the engineering organization to make sure all its personnel are effectively trained to carry out their responsibilities in a way that is consistent with the documented quality system. The documented training program should teach quality and quality management issues to all personnel directly affecting the quality of E&D products, reconcile needed skills with skills possessed by every member of the organization, be adequately funded, evaluate the effectiveness of the training, and conduct post-training assessments.

Guidelines for Conformity

- ✓ Is a procedure in place for identifying training needs for all personnel performing activities affecting engineering and design quality?

- ✓ Are personnel adequately trained in terms of needed skills and knowledge to perform their jobs effectively?
- ✓ Do training records exist for all employees, and are they properly maintained?
- ✓ Is there a central person or organizational entity that maintains individual training records and programs?
- ✓ Do self-help and independent training aids exist?
- ✓ Does the training program cover quality awareness for all USACE personnel from district engineer level down?
- ✓ Does the training program cover revisions to existing procedures?

SERVICING (4.19)

Description

Requires the engineering organization to establish and document procedures for providing postdesign services appropriate to the needs of its customers such as legal, contracting, and financial closeout. Appropriate records of service-related activities should be maintained.

Guidelines for Conformity

- ✓ Are procedures established for providing specified services to the customers?
- ✓ Where required, are service actions meeting USACE customer expectations?
- ✓ Are the appropriate USACE personnel trained in providing "after sales" services?
- ✓ Does the engineering organization perform periodic reviews of completed construction projects to ensure that specific elements function as they were designed and intended?

STATISTICAL TECHNIQUES (4.20)

Description

Requires the engineering organization to establish and maintain statistical techniques, where appropriate, for verifying product acceptability during design development, process control, final design characteristics, and testing and quality control equipment.

Guidelines for Conformity

- ✓ Are appropriate statistical techniques identified and used to determine design process capabilities, product characteristics, nonconforming product, test and inspection control, process control, and customer complaints?
- ✓ Are the process variables and their effects on the finished product understood?
- ✓ Are those statistical techniques properly used and reviewed for consistency in application?
- ✓ Are the appropriate personnel trained in the use and analysis of those techniques?
- ✓ Are all statistical procedures followed and kept current?

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13. ABSTRACT ***(Maximum 200 words)***

If it is to continue as the world's preeminent engineering and design organization, the U.S. Army Corps of Engineers (USACE) must fulfill its customers' demand for total quality products and excellent service. To Corps customers total quality means engineering and design products that meet their functional and technical requirements, are completed on schedule and within the given budget, and are delivered with exceptional customer service. In response to its customers' challenges, USACE has already launched several quality-related initiatives (e.g., *Total Army Quality*). However, those quality initiatives, as a whole, could be much more beneficial to the field activities implementing them if they were made part of a broader and integrated quality management system that would minimize lapses in quality by preventing most problems. When problems do arise, the system quickly identifies and corrects the faulty systems or procedures. Fortunately for USACE, a ready recipe for acceptable quality management systems — the ISO 9000 quality system standards — already exists.

The ISO 9000 standards, developed by the International Organization for Standards, are a series of generic quality system criteria that provide the fundamental framework for universally accepted quality management systems and establish the basic elements that comprise those systems. The European Economic Community is already using ISO 9000 to verify the legitimacy of quality systems across national boundaries. In the United States, ISO registration is growing rapidly because in certain industries, registration under ISO 9000 is contractually mandated or part of contractor selection criteria. For other quality-conscious firms, ISO standards offer a ready model for improving internal quality systems and therefore, efficiency, competitiveness, and productivity. Most registered companies are finding that the benefits of registering under ISO exceed the costs.

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